SPECIAL AUDIO ISSUE

RADIO & TELEVISION NEWS

NOVEMBER
1950
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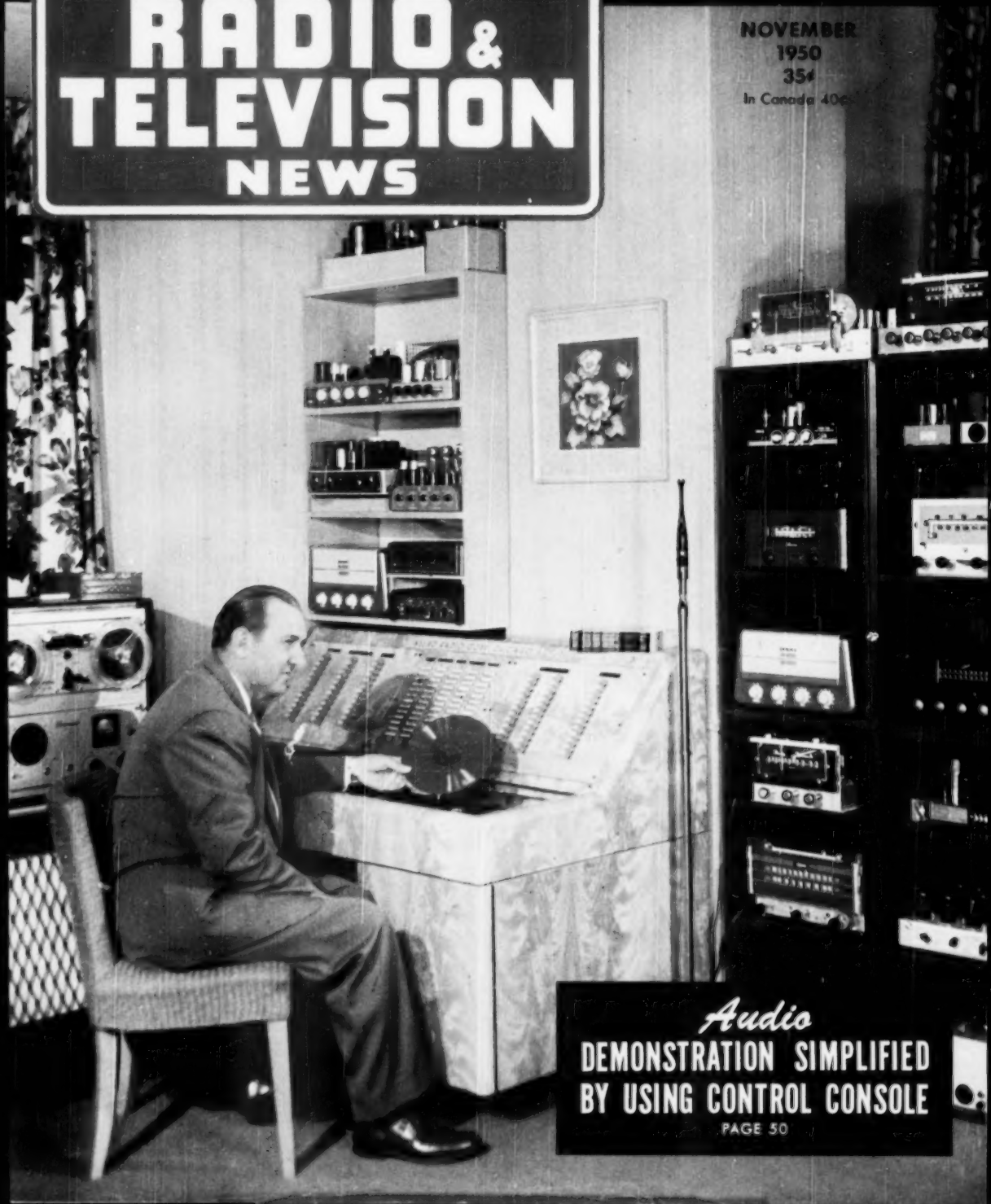

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PAGE 50

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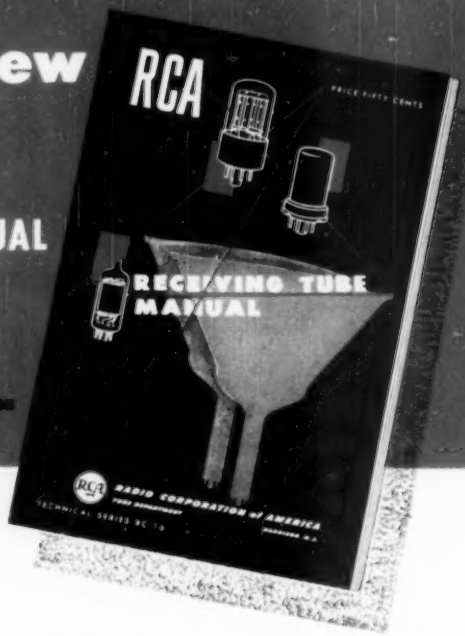

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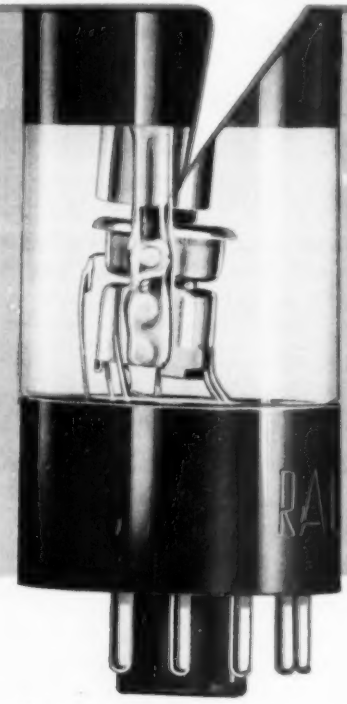

The response to Rauland's new Indicator Ion Trap, after its introduction in the 12LP4-A, has been so enthusiastic that this feature has now been incorporated in all Rauland tubes—as a standard feature of the new Rauland Tilted Offset Gun.

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For the RECORD

BY THE EDITOR

AT LEAST "MINIMUM SERVICE" ESSENTIAL TO TV'S FUTURE

THE editors of RADIO & TELEVISION NEWS have made an exclusive arrangement with the Television Technicians Lecture Bureau to bring to our radio and TV service technicians "on the spot" analysis of problems of the service industry.

As a sponsor of these nationwide educational programs, this magazine will serve as a medium for constructive action on matters vital to the welfare of the technician.

A new department, "Radio-TV Service Industry News," will be featured each month and will include information on business trends in the Service Industry as well as data on all other developments which are of interest to Radio-TV Service Shop operators and technicians.

Very serious problems face the entire Radio-TV Service Industry. Military demands for trained technicians must be satisfied of course. This means that technicians whose job it is to keep receivers going in millions of homes will be in great demand. Not nearly enough qualified men will remain to serve the civilian market. Many will be working in factories producing military electronic equipment.

The rate of reduction of potential service technicians is already quite alarming. Various Associations are reporting considerable loss of membership as qualified men become absorbed by Industry and the Military.

Our Government recognizes the "morale value" of communications in the home and is cognizant of the need for keeping receivers in working order. But—these are serious times and demands for military personnel must have priority.

It will be the basis and purpose of "Radio-TV Service Industry News" to constantly analyze the field and to offer some real practical help in meeting the many problems confronting all radio-television technicians.

We must preserve the radio-television service industry as long as it does not weaken our defense program. We need the full support of the broadcasters and telecasters. They stand to lose a dwindling audience if listeners and viewers do not get at least "minimum service" on their sets.

Technicians entering our industry from schools will require time to gain practical experience in the field before they reach maximum production and learn the many peculiar problems of their own communities. Set production, in the meantime, continues at a record breaking pace in spite of shortages of parts, tubes, and manpower.

In an open letter to leaders in the television industry, Mr. A. M. Haas of Television Contractors Association states, "We think that the Government should give further consideration to an idea it has previously espoused because of the kind of war we may have today: dispersion of industry and the encouragement and support of secondary industrial reserves. Because of the vastness of our electronics program we believe the Government should think in terms of some television service shops becoming components in a 'National Industrial Reserve System.' It is obvious that our big industrial centers would be the first targets in an all-out war. If an enemy was successful in hitting some of our concentrated electronic industries we would have little to turn to for our electronic needs. But, if we prevented the disintegration of our television service shops, with their highly skilled technicians and their arrays of manufacturing and testing equipment, we might be able to utilize this resource."

We feel such a plan is feasible and workable. This could be at least a partial solution to one problem.

Other problems appear daily and there are many more to come. The participation by RADIO & TELEVISION NEWS in the Lecture Bureau activities will, we feel, be of great value to all technicians in solving these many present and future problems.

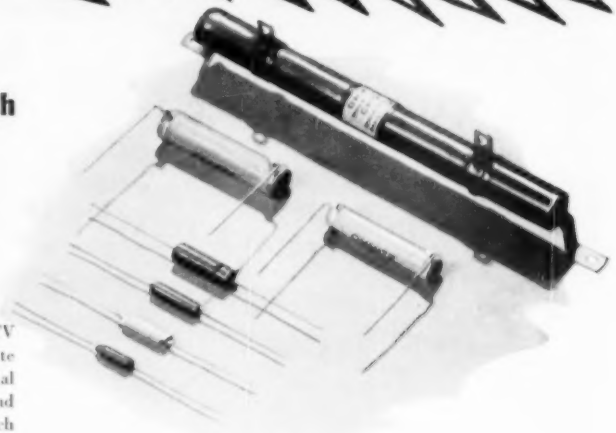
This will be your department and we need your comments and suggestions. We will have many problems analyzed by our panel of experts right in the field of radio and television servicing.

Send in your problems now for inclusion in the Department. They will be studied and passed on to the TTLB for comment and suggestion. Specially prepared feature articles will also result from our participation in this program. They'll be constructive and thought provoking—all written with one thought in mind—to add to the stature of radio-television servicing.

. . . . . O.R.

HOW TO REDUCE TV INTERFERENCE

Use Wave Traps Made With OHMITE "Frequency-Rated" CHOKES



There are many cases where the front end of a TV receiver lacks the selectivity required to eliminate very strong 14 or 28 Mc signals. These fundamental frequencies jam through the receiver front end and create many kinds of cross-modulation products which affect the viewed picture (not to mention the set-owner's temper). The only solution: each receiver affected must be treated separately, to prevent such fundamental frequencies from getting in and affecting the TV signal.

Tuned wave traps—either series, parallel, or combination types—are most commonly used to eliminate this trouble. They can be made effectively with Ohmite high-Q Chokes, in combination with suitable trimmer capacitors. (See diagrams at the right.)

Since most receivers have 300-ohm input, that type has been treated here. These designs, however, can be adapted to 72-ohm input as well. Series-tuned traps are connected from the receiver terminals to ground. In some cases, however, two parallel-tuned traps may prove equally satisfactory. The chokes and trimmers can be mounted on a small terminal board with binding posts or clips for easy installation.

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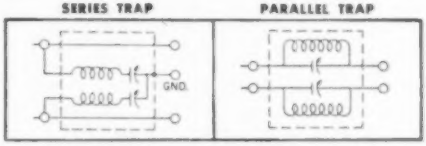

Table below shows approximate capacity necessary to resonate OHMITE Frequency-Rated Chokes at various frequencies:

OHMITE CHOKE	mmf at 3.5 Mc	mmf at 7 Mc	mmf at 14 Mc	mmf at 21 Mc	mmf at 28 Mc	mmf at 50 Mc	mmf at 56 Mc
Z-28	98	25	6.2				
Z-50		74	19	8.2	4.6		
Z-144			72	32	18	5.7	4.5
Z-235				69	39	12	9.7
Z-460						51	40

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National Schools prepares you for your choice of many job opportunities. Thousands of home, portable, and auto radios are being sold daily—more than ever before. Television is sweeping the country, too. Co-axial cables now under construction will soon bring Television to every city, town, and farm! National Schools' *complete* training program qualifies you in all fields. Read this partial list of opportunities for trained technicians:

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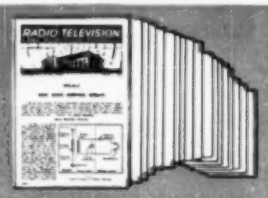

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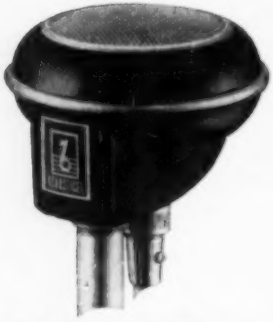

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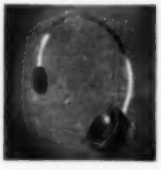

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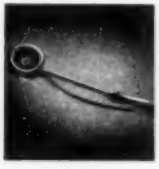

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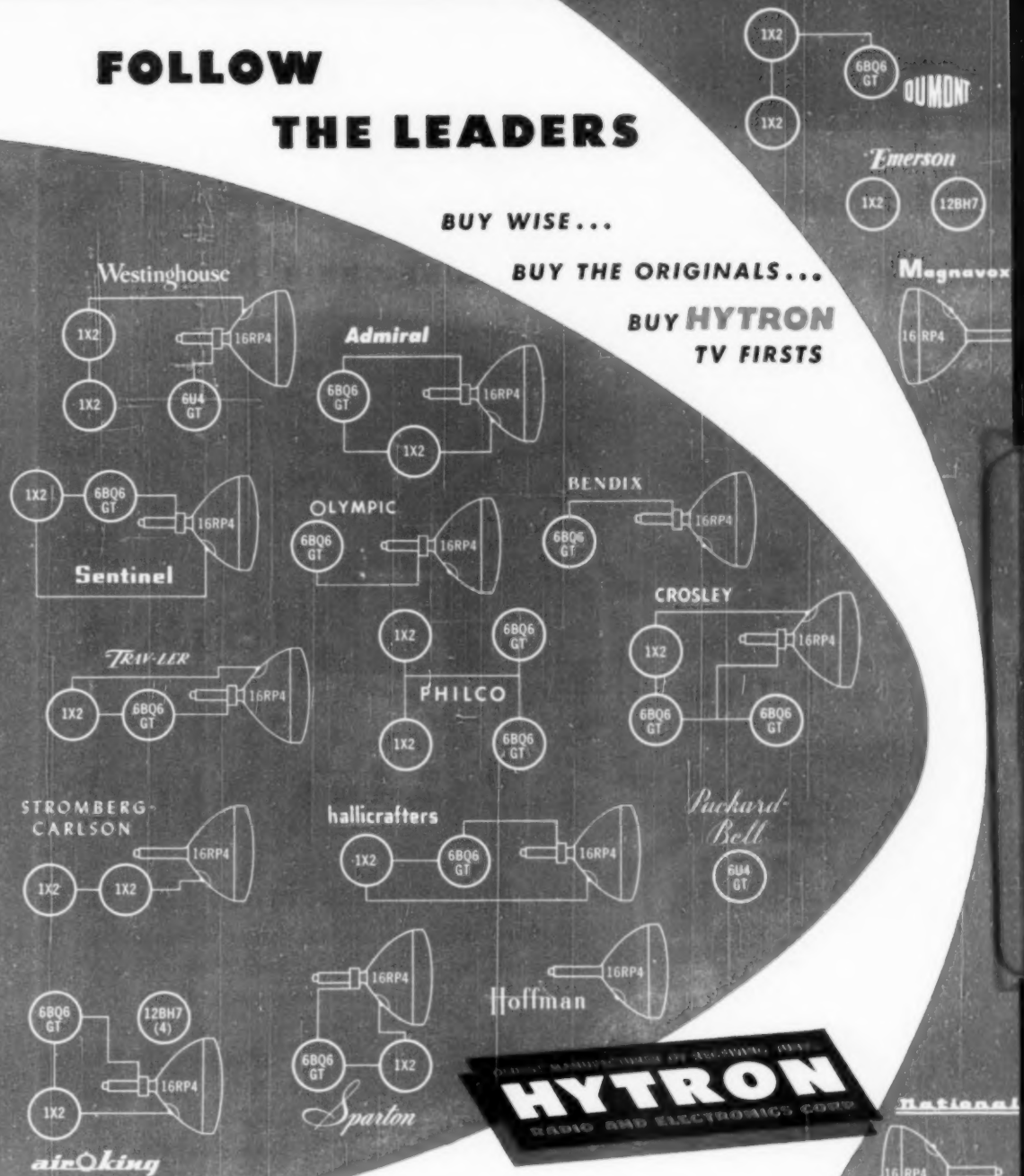

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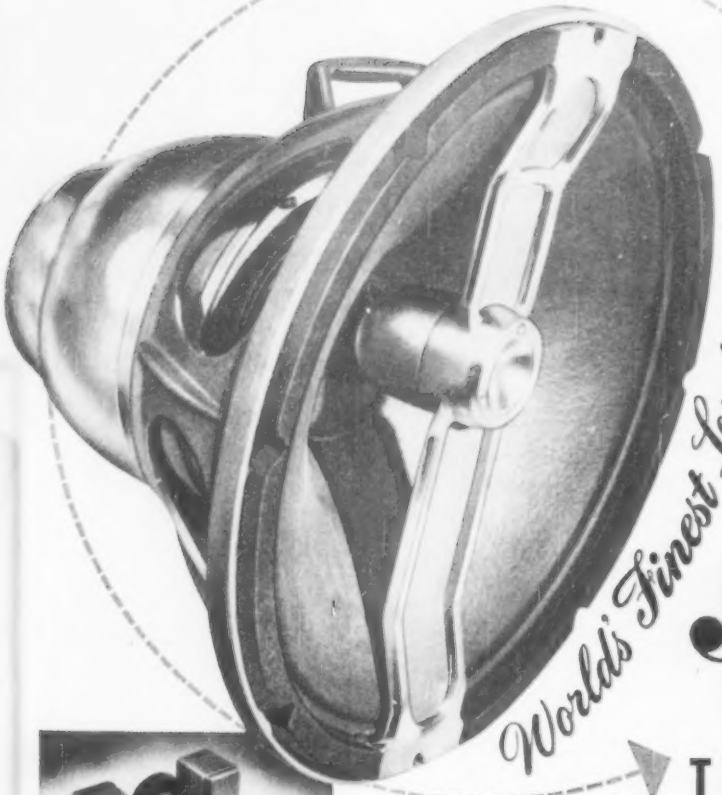

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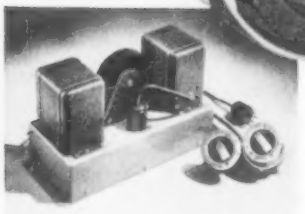
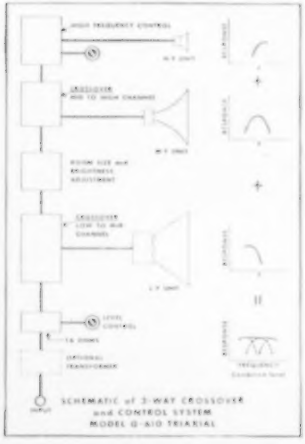




SCHEMATIC of 3-WAY CROSSOVER and CONTROL SYSTEM MODEL G-610 TRIAXIAL

Never Before Reproduction Like This!

The G-610 brings a totally new meaning to high fidelity sound reproduction. Not only does this new 3-channel system reproduce the widest frequency range ever attained by a loudspeaker, but it also sets new high standards with its incomparably smooth response characteristic and very low distortion. The result is clear, clean, life-like quality, with thrilling *transport to the original* such as you have never heard before. The G-610, complete with Speaker Unit and Crossover and Control network is priced at $365.00 list. Ask for Data Sheet 160.

Jensen *Manufacturing Company*

Division of the Muter Company

6617 SOUTH LARAMIE AVENUE, CHICAGO 38, ILLINOIS

More light on the radio tube situation . . .

AN OPEN LETTER TO RADIO SERVICE DEALERS

SYLVANIA ELECTRIC PRODUCTS INC.

EMPORIUM • PENNSYLVANIA

First of all, we want to thank all of you good service dealer friends for your loyalty and cooperation.

Here are the FACTS: Even before the Korean trouble, the increasing demand for Sylvania Tubes was keeping our factories on round-the-clock production schedules. With the meteoric growth of television, still greater production facilities were needed.

Since the Korean war a flurry of buying by industrial customers and the service industry alike soon reduced warehouse and factory stocks to an all-time low.

Here's how Sylvania protects you now: To make certain that all of its regular service dealer customers are protected in this period of limited supply, Sylvania has effected a three-fold program of protection.

1. Production facilities have been greatly increased. Two additional plants have already been placed in operation. Another is under construction.
2. Your Sylvania radio and television tube suppliers are now being taken care of on an allocation plan, which we feel is established on the fairest possible basis.
3. Sylvania will continue to supply you with complete technical information for your service work, including latest data on substitution of available types for critical types.

Sylvania realizes that in the months ahead the whole country will depend upon you service dealers to keep its radios, TV sets and communications equipment in top working order. Your Sylvania Distributor will not have all the tubes you want but will do his best to serve you. We feel a deep obligation to give you the greatest possible aid in doing this job, but naturally, our country's defense needs come first.

As we have demonstrated in the past, Sylvania is ever mindful of the importance of its Service Dealers and servicemen to the nation and to the industry. We will continue to do everything possible to preserve the fine relationship existing between Sylvania, its distributors, and you, its loyal dealer customers.

Cordially yours,
SYLVANIA ELECTRIC PRODUCTS INC.
H. N. Rainer
Manager, Distributor Sales

INCANDESCENT LAMPS • RADIO TUBES • FLUORESCENT LAMPS AND FIXTURES • ELECTRONIC DEVICES

Spot Radio News

★ *Presenting latest information on the Radio Industry.*

By RADIO & TELEVISION NEWS' WASHINGTON EDITOR

THE RED, GREEN AND BLUE TV fracas, which has been quite a blazing affair for nearly ten years and destined to continue *ad infinitum*, came to a screeching halt as the summer ended when the august body of seven electronic jurists of Washington finally unfurled a plan to end, at least temporarily, the color-fest. The plan, to the dismay of many, and the delight of some, routed the prize cup into the halls of *CBS* for a tenure which may end early next year, or be labeled permanent for many years. The award can bounce back to Princeton or San Francisco, if *RCA* or *CTI* can show that their systems can do a better job, these proponents having until to December 5 to produce the equipment that will or will not sparkle, and until January 5 to process a report outlining their improvements. In the meantime, the *CBS* field-sequential method has become the white-haired idol and industry will have to provide the means to receive the 405-line pictures in black and white. Actually the FCC *told* industry that they *must* provide chassis with a manual or automatic switch which will provide instantaneous selection of the standard 525 or color's 405 lines, or there'll be no further consideration of other possible tri-hued ideas and the *CBS* plan will become the basis of official color standards.

The cold, blunt edict to the manufacturers was issued, according to the FCC, because they felt that they . . . "cannot postpone a color decision since each day that passes would aggravate the compatibility problem." In their opinion, if a decision were to be made now, the *CBS* system would be adopted, but if a procedure can be devised whereby the compatibility problem would not be intensified, they would be willing to look further into the consideration of four basic matters: (1) The utilization of direct-view tubes larger than the 12½ inches used in the *CBS* system; (2) the use of horizontal interlace; (3) the use of long-persistence phosphors; and (4) the development of new compatible systems or improvements in compatible systems which have been informally called to the Commission's attention since the hearing record was closed.

THE CONCLUSIONS REACHED by the Commission cited that the *CBS* system looked best to them, because it complied with more of the requirements set forth in the seven-point system criteria issued before the hearings began. In their list of performance virtues which a system had to meet before it could be considered eligible for adoption, the Commission pointed out that the system . . . "must be capable of operating within a 6-megacycle channel allocation structure, and must be capable of producing a color picture which has a high quality of color fidelity, adequate apparent definition, good picture texture and is not marred by such defects as misregistration, line crawl, jitter, or unduly prominent dot or other structure." The FCC also asked that the . . . "color picture be sufficiently bright so as to permit an adequate contrast range and be capable of being viewed under normal home conditions without objectionable flicker." In addition, the governmental body asked that the system be . . . "capable of operating through receiver apparatus that is simple in the home, does not have critical registration or color controls, and is cheap enough in price to be available to the great mass of the American purchasing public" . . . and . . . "be capable of operating through apparatus at the station that is technically within the competence of the type of trained personnel hired by the station owner who does not have an extensive research or engineering staff at his disposal, and the costs of purchase, operation, and maintenance of such equipment must not be so high as to unduly restrict the class of persons who can afford to operate a television station." The concluding requirements stated that the system . . . "must not be unduly susceptible to interference as compared with the present monochrome system, and must be capable of transmitting color programs over intercity relay facilities presently in existence or which may be developed in the foreseeable future."

Reviewing these criteria, the Commission pointed out that compatibility, the term over which the experts wrangled for weeks and weeks, was not even mentioned. Qualifying this omission, the Federal specialists declared that if a . . . "satisfactory compatible system were available, it would certainly be desirable to adopt

Over 50,000 SERVICEMEN must be right!

NEW.. EICO Instruments and KITS

give you Laboratory Precision at Lowest Cost!

VACUUM TUBE VOLTMETER

Versatile top-quality laboratory-precision VTVM for trigger-fast operation and lifetime dependable service.

15 different ranges. Large rugged 4½" meter, can't-burn-out circuit. New zero center for TV & FM discriminator alignment. Electronic AC & DC ranges: 0-5, 10, 100, 500, 1000 v. (30,000 volts and 200 MC with HVP-1 and P-75 probes). Ohmmeter ranges, .2 ohms to 1000 megs. DB scale. New stable double-triode balanced bridge circuit—extreme accuracy. 26 megs DC input impedance. Attractive 3-color etched rubproof panel; rugged steel case. 115 v., 60 cycle AC. 9-7/12 x 6 x 3".

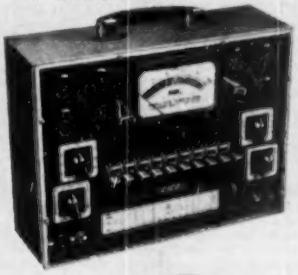
Model 221-K, KIT, only $23.95
Model 221, factory wired, $49.95

New TUBE-TESTER

The *brand new* professional tube tester and merchandiser EICO Service-Engineered for unbeatable value!

Large 4½" full-vision meter. Tests *conventional and TV tubes* including 9-pin miniatures. New lever-action switches—tests *every* tube element. Illuminated "Speedrol Chart." 2 grid caps. Short and open-element tests. Spare socket for new tubes. Protective overload bulb. Electronic rectifier. Handsome 3-color etched rubproof panel; rugged steel case. 115 v., 60 cycle AC. 12½ x 9⅛ x 4¼".

Model 625-K, KIT, only $29.95
Model 625, factory wired, $44.95



5" PUSH-PULL OSCILLOSCOPE

All-new laboratory-precision scope gives you all the extra sensitivity and response for precise servicing of TV, FM & AM receivers.

Push-pull undistorted vertical and horizontal amplifiers. Boosted sensitivity, .05 to .1 rms volts/inch. Useful to 2.5 MC. TV-type multivibrator sweep circuits, 15 cps—75 KC. Z-axis intensity modulation feature. Dual positioning controls move trace anywhere on screen. Complete with 2-6J5, 3-6SN7, 2-5Y3, 5BP1 CRT. Handsome 3-color etched rubproof panel; rugged steel case. 115 v., 60 cycle AC. 8½ x 17 x 13".

Model 425-K, KIT, only $39.95
Model 425, factory wired, $69.95

RF PROBE

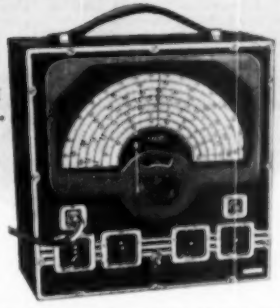
Sensitive Germanium crystal probe for signal tracing and measurements to over 200 MC. Extends range of VTVMs and scopes.

Model P-75K KIT, for VTVM; P-76K for Scope; ea. $3.75
Model P-75 or P-76, factory wired, ea. $7.50

HIGH VOLTAGE PROBE

A new professional EICO-engineered HV probe carefully designed and insulated for extra safety and versatility. Extends range of VTVMs and voltmeters up to 30,000 volts. Lucite head. Large finger-guards. Multi-layer grounded handle. Complete with inter-changeable ceramic multiplier to match your instrument.

Model HVP-1, only $6.95



New Deluxe Kit
AM-FM-TV SIGNAL GENERATOR

A laboratory-precision generator EICO Service-Engineered with 1% accuracy.

Extremely stable, frequency 75 KC—150 MC in 7 calibrated ranges. Illuminated bairline *vernier tuning*. VR stabilized line supply. 400-cycle pure sine wave with less than 5% distortion. Tube complement: 6R5, 7F7, 6C4, VR-150. Handsome 3-color etched rubproof panel; rugged steel case. 115 v., 60 cycle AC. 12 x 13 x 7".

Model 315-K, KIT, only $39.95
Model 315, factory wired, $59.95

New BATTERY ELIMINATOR & CHARGER

The *brand new* 6-volt power supply EICO Service-Engineered for extra reserve electrical power for all auto radio testing.

Latest-type full wave bridge circuit, extra-heavy-duty 4 stack manganese copper oxide rectifiers. Latest Variac-type transformer. 0-15 volts output. Continuous operation: 5-8 v., 10 amps, intermittent: 20 amps. 10,000 mfd filter condenser. Rugged meter measures current and voltage output. Double protection: fused primary; automatic reset overload device for secondary. Handsome rugged hammertone steel cabinet. 115 v., 60 cycle AC. 10⅛ x 7¾ x 8¾"

Model 1040-K, KIT, only $22.95
Model 1040, factory wired, $39.95

Easy-to-follow step-by-step EICO pictorial & schematic instructions—most explicit & comprehensive in electronics!—supplied with each Kit. Anyone can build the EICO Kits!

See these other EICO Instrument KITS:

Model 320-K Sig Gen KIT, $19.95
Model 360-K Sweep Gen KIT, $29.95
Model 145-K Sig Tracer KIT, $18.95
Model 511-K VOM KIT, $14.95

Due to unsettled conditions, all prices are subject to change without notice.

Be sure to look at the EICO line before you buy any higher-priced equipment! From etched rubproof panel to modern engineering design, each EICO Kit and Instrument is jam-packed with unbelievable value to satisfy the most exacting engineering requirements. YOU be the judge—compare EICO at your local jobber today, and SAVE! Write TODAY for free latest Catalog 8 describing the complete EICO line.

Prices 5% higher on West Coast

the exclusive EICO Make-Good GUARANTEE

Each EICO Kit and Instrument is *doubly guaranteed*, by EICO and your jobber to contain only selected quality components. EICO guarantees to replace any component which might become defective in normal use if returned to the factory within 90 days of purchase. EICO guarantees all Kits assembled according to EICO's simplified instructions will operate as specified therein. EICO guarantees service and calibration of every EICO Kit and Instrument at the nominal charge as stated in the instructions.

ELECTRONIC INSTRUMENT COMPANY, INC.
276 Newport St., Brooklyn 12, N. Y.

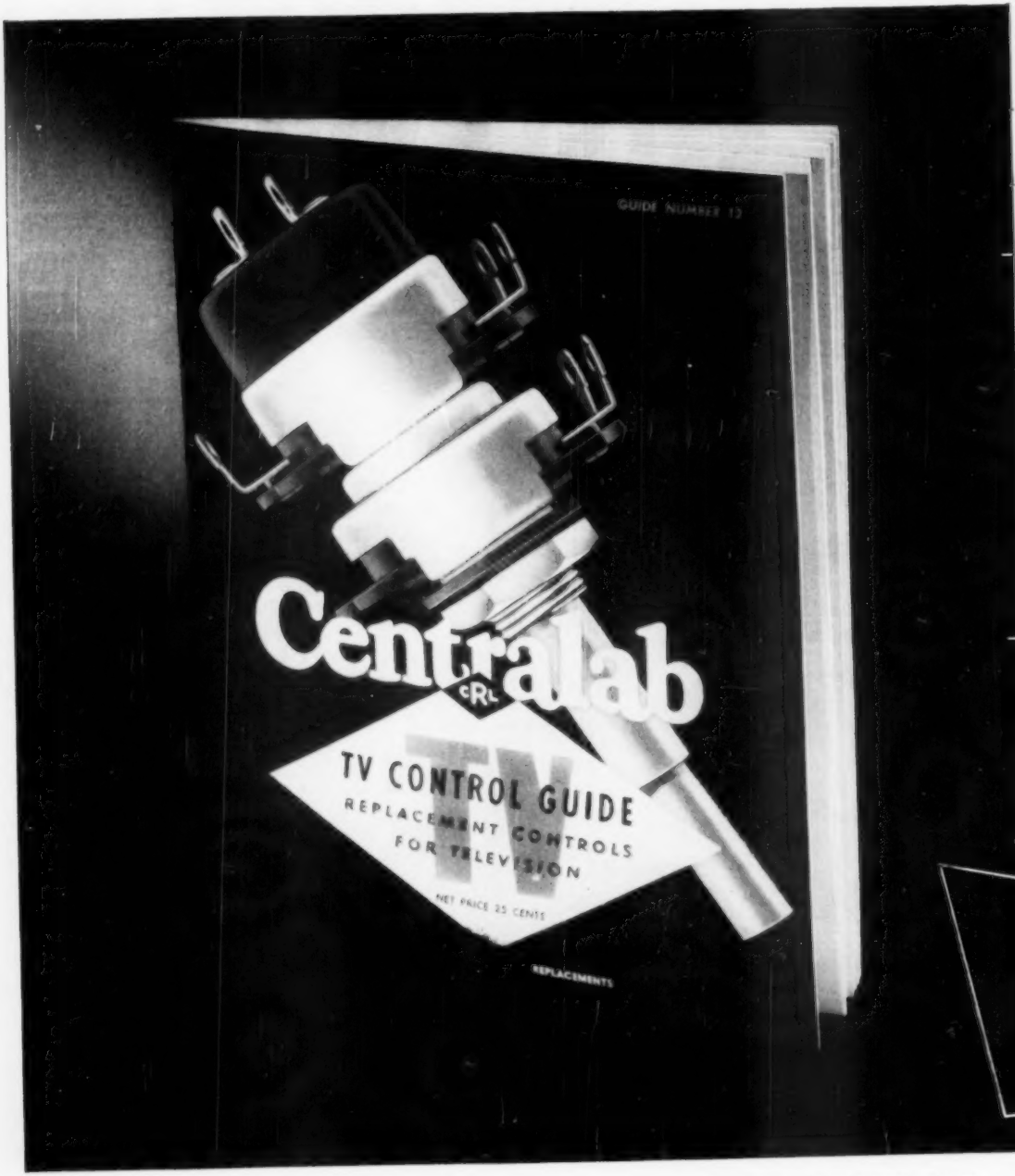
such a system. Compatibility would facilitate, for the broadcaster, the transition from black and white broadcasting to color broadcasting and would reduce to a minimum the obsolescence problem of present receivers. However . . . no satisfactory compatible system was demonstrated in these proceedings." The Commission then added that, in their opinion . . . "based upon a study of the history of color development over the past ten years, from a technical point of view, compatibility, as represented by all the color television systems which have been demonstrated to date, is too high a price to put on color. . . . The receiver aspect of compatibility, moreover, is merely a temporary problem which will decrease progressively each year, once receivers are built incorporating new standards. Based on the assumption of seven million sets in the hands of the public at the present time, the problem of compatibility would be diluted each year depending on the annual rate of production."

ONE PERSON in Washington particularly happy about the decision, was Senator Edwin Johnson, who has been campaigning for a definite answer on color. Said the Senator, in a letter to FCC Headman Wayne Coy, . . . "The decision brings very close the day when this great new improvement . . . will serve the American people. . . . Leaving the door partly ajar, affording an opportunity to the Johnny-come-latelys, is a challenge to them to produce or step aside. Moreover, it is in the best traditions of American democracy and the free enterprise system, since it does not foreclose improvements, which I am sure our American electronic science may bring out. . . . I know that every effort will be made to push forward rapidly the allocation decisions so that television will be made available to many more millions of citizens who are waiting impatiently to have television in their homes."

The opinions of the Commission appeared in a report, rather than a formal decision, which implied that further considerations of the important subject would be held. The report, a 48-page effort, covered practically every facet of the color issue. In a section on the superposition of color images, for instance, the registration, color breakup, and color fringing properties of the three systems were reviewed thoroughly. Detailing the registration characteristics of the *CTI* system, the report said: "There is a severe registration problem at the camera and receiver. At the camera end, the optical system must be so adjusted and maintained that the image being transmitted falls upon the three separate color bands of the tube in exactly the same relative position. . . . At the receiver end, the same precise adjustments must be made. . . . It is exceedingly diffi-

(*Continued on page* 112)

announcing CENTRALAB'S



new TV CONTROL GUIDE

Service engineers! Here's the industry's most complete reference for TV control service . . . Lists 1600 controls . . . for all popular models.

A TIME-SAVER FOR YOU

Centralab's *new* TV Control Guide lets you get *all controls you need from your Independent Parts Jobber. One source—* one stop—for CENTRALAB QUICKEST FOR SERVICING CONTROLS.

Yes! Centralab's new TV Control Guide is an absolute "must" for up-to-the-minute TV service engineers. It's a big time-saver when you can have one source for your special TV controls . . . controls that are ready to go — no time lost fumbling with assembly.

A BONUS FOR YOU — The new guide also contains the industry's *FIRST* PRINTED ELECTRONIC CIRCUIT REPLACEMENT LISTING. It shows you over 100 listings that can be serviced by only 11 standard Centralab printed circuit plates — all stock items.

Centralab
ERL®
Division of GLOBE-UNION INC., Milwaukee

Order your copy now, only 25c

Order your copy of Centralab's new TV Control Guide now. If you act promptly, you'll not only get the guide and the Printed Circuit lists — we will include a *price list and a valuable special control bulletin on custom controls for older radio models.* Send 25 cents in stamps or coin together with the coupon below. You'll get your new TV Control Guide with all its other valuable features by return mail. Order now while the supply lasts.

TEAR OUT... MAIL AT ONCE 25c

Centralab Division of Globe-Union Inc., 910 E. Keefe Ave., Milwaukee, Wis.

I enclose 25 cents for Centralab's new TV Control Guide together with the Printed Electronic Circuit listing. Also include price list and listing of custom controls for older radios.

Name.....

Address.....

City..... Zone..... State.....

Please!
I am a ☐ Service Engineer ☐ Ham ☐ Jobber ☐ Tv Set-Owner.

ASSURES YOU the most complete tests of all tubes including television.

ACTUALLY APPLIES 19 separate filament voltages—eliminates usual compromises.

TESTS OVER 700 tubes listed on roll chart—Many thousand tubes used to properly evaluate correct settings.

POSITIVE INDIVIDUAL test of each element.

SPECIAL CIRCUIT feature accurately compensates to provide correct voltages on each tube test.

IMPROVED LEVER switching originated by Triplett for complete control of each tube element.

EACH ELEMENT quickly and conclusively tested for shorts by a flip of the switch.

ILLUMINATED SPEED-ROLL chart with latest tube listings. Kept up-to-date.

LARGE 6" meter—RED-DOT Life-time Guaranteed.

FOR COUNTER or portable use.

TRIPLETT

MODEL 3413
TUBE TESTER
Only
$69.50

COMPLETE WITH ACCESSORIES AND INSTRUCTION MANUAL

In Canada: Triplett Instruments of Canada, Georgetown, Ontario

FOR THE MAN WHO TAKES PRIDE IN HIS WORK

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TRIPLETT ELECTRICAL INSTRUMENT COMPANY - BLUFFTON, OHIO, U.S.A.

REPLACEMENT OR REFUND OF MONEY
Guaranteed by Good Housekeeping
IF NOT AS ADVERTISED THEREIN

GRANTED TO...

RAYTHEON TELEVISION

ANOTHER PROOF OF RAYTHEON DEPENDABILITY!

THE MARQUIS
Model C-1714

As Advertised in Life, Good Housekeeping, Saturday Evening Post

BELMONT RADIO CORPORATION
3921 W. Dickens Avenue, Chicago 39, Ill.
Subsidiary of RAYTHEON MFG. CO.

You know how important that GOOD HOUSEKEEPING guaranty seal is . . . what thorough testing a product must go through before it is guaranteed as advertised in GOOD HOUSEKEEPING. Now—that famous seal is granted to the entire line of RAYTHEON television sets!

It's another proof of the dependability of Raytheon. And no wonder! Every Raytheon set is precision engineered . . . made of top-quality parts and materials . . . to give outstanding performance. Raytheon uses no short cuts—leaves out no parts—in order to cut prices. All reasons why you can place full confidence in Raytheon!

See the beautiful new models now available in the 1951 Raytheon line. Every one is dependably built for dependable performance!

List Prices Range from $189.95 to $625.00

Here's Plus Proof That Every Raytheon Set Is...

Backed by a liberal One-year Warranty!

Backed by the Underwriters' Laboratories Seal!

Made by a leader in electronics for 25 years!

Dependably Built for Dependable Performance

Within the INDUSTRY

WARREN FREBEL has joined *Majestic Radio & Television, Inc.* of Brooklyn, New York as purchasing agent of the company. Mr. Frebel was formerly purchasing director at *Meck Industries, Inc.* for a period of five years.

During World War II, Mr. Frebel served in the U. S. Signal Corp for four years and prior to his military service was associated with *Wilson & Company*. He attended the University of Illinois.

* * *

DR. PETER C. GOLDMARK has been appointed to the post of vice-president in charge of engineering research and development by the *Columbia Broadcasting System*. He has been actively engaged in the research work in connection with *CBS's* color television for some time . . . **ROBERT S. BELL**, formerly vice-president and assistant general manager of *Packard-Bell Co.* of Los Angeles, was named executive vice-president of the company at a recent meeting of the board of directors . . . **B. L. BETHEL**, for 25 years a purchasing executive in the electronics and related fields, has been named vice-president in charge of purchasing for *John Meck Industries* of Plymouth, Indiana . . . **W. D. LOUGHLIN** has been elected chairman of the board of *Boonton Radio Corporation*. **DR. G. A. DOWNSBROUGH** and **DR. D. M. HILL** have been named president and vice-president in charge of research and development respectively . . . **R. C. FREYTAG** is the new vice-president of *Scott Radio Laboratories*. He formerly served in executive capacities in the personnel and administration divisions.

* * *

FRANK W. MANSFIELD of *Sylvania Electric Products Inc.* was reappointed chairman of the eleven-man Industry Statistics Committee of the Radio-Television Manufacturers Association.

The committee, composed of marketing research and statistical experts, supervises the compilation of all statistics on the radio-television industry published by RTMA.

Serving with Mr. Mansfield are the following men: L. K. Alexander, *General Electric Company;* E. C. Anderson, *Radio Corporation of America;* George A. Biese, *Crosley Division, Avco Mfg. Corp.;* H. W. Clough, *Belden Manufacturing Co.;* Paul Eashleman, *Allen B. Du Mont Laboratories, Inc.;* P. J. Halligan, Jr., *Philco Corporation;* G. W. Henyan, *General Electric Company;* George McCleary, *RCA Victor Division;* W. J. Rinkenback, *Capehart-Farnsworth Corp.;* and A. G. Schifino, *Stromberg-Carlson Co.*

* * *

VIBRATION RESEARCH LABORATORIES, INC. has been formed recently by Joseph A. Mas as a research, development, and manufacturing corporation. Headquarters of the new firm are at 152 Sandford Street, Brooklyn, N. Y. . . . John S. Starrett and Russell E. Kraft have joined forces in the formation of a new firm, **UNITED TECHNICAL LABS.** at Morristown, New Jersey. Mr. Starret was formerly associated with the *RCA Tube Department* while Mr. Kraft was connected with *Sun Dial Corp.* and *Radio Frequency Labs.* of Boonton, N. J. . . . Formation of **ARDEC, INC.**, a Pennsylvania corporation specializing in the production of precision parts and assemblies on a production line basis for the aircraft, automotive, instrument, electronic, and allied industries, has been announced. The company's plant and general offices are located at Media Road and South Orange Street in Media, Pa.

* * *

HOWARD E. ANTHONY, president of *The Heath Company* of Benton Harbor, Michigan, has been awarded the honorary degree of Doctor of Science in Electronics by the University of Hollywood, Hollywood, California.

The degree was conferred on Mr. Anthony "in recognition of the valuable contributions he has made to the industrial electronics field and in further recognition of his genius and skill by which he has made available to the electronics industry and to the electronics engineer essential electronic testing equipment which is now being used in scientific and electronic research work."

The presentation was made by Dr. Oliver Read, editor of RADIO & TELEVISION NEWS, at a testimonial luncheon held recently in Benton Harbor.

Mayor Gideon and other leading citizens of Benton Harbor paid tribute to Dr. Anthony for this recognition in the field of electronics and also cited him for his leadership in his community both as an electronic engineer and as one of Benton Harbor's most civic-minded and popular citizens.

* * *

GEORGE P. FRYLING, chairman of the board of *Erie Resistor Corporation*, died recently in Erie, Pa. after a brief illness. He was 85 years old.

Mr. Fryling is survived by two sons,

IT'S HERE!

The New HIR

a fully automatic ANTENNA ROTATOR by ALLIANCE

with the most accurate indicator on the market!

Just set the pointer and forget it!
Works in any weather
Guaranteed for one year

The famous Model DIR also available with handy—North—South—East—West indicator. Approved by Underwriters' Laboratories—guaranteed for one year!

AUTOMATIC—the new deluxe model HIR Alliance Tenna-Rotor is fully automatic. Turn the indicator knob and the antenna turns to any setting on the dial and stops.

FASTER INSTALLATION — Easily accessible connections. Uses special "Zip" feature 4-conductor cable. No expensive callbacks necessary.

NEVER OUT OF DATE—mark the best antenna position for each station right on the dial with removable stickers. New channels can be added at any time by customer.

MYSTIC LIGHT — light moves along the dial, shows position while antenna turns. Pointer indicates antenna position at all times. Dial shows North—East—South—West directions.

And Remember—
Only Alliance delivers a national TV campaign to five million viewers around 60 stations.

It pays to stock and sell Alliance Tenna-Rotor!

Alliance Manufacturing Co.
Alliance, Ohio
Export Department: 401 Broadway, New York, N. Y., U. S. A.

alliance
TENNA • ROTOR
(TV ANTENNA ROTATOR)

G. Richard Fryling, president, and W. Henry Fryling, vice-president of the *Erie Resistor Corporation*.

From 1901 to 1925 he was secretary-treasurer of *Speer Carbon Company* of St. Mary's, Pa., and served as president of the *Elk Graphite Milling Company* of that same city from 1905 to 1935. In 1928 he and his two sons founded the company he headed at the time of his death.

* * *

ANTHONY J. ALBANO, chief engineer of the *Tel-O-Tube Corporation of America*, East Paterson, New Jersey, has been elected secretary of the corporation, according to word received from the company.

Mr. Albano has had extensive experience in radio, electronics, and television. Prior to joining the company two years ago, he served as production engineer for the *Allen B. Du Mont Laboratories*. He is an alumnus of Newark College of Engineering and during the war served as an electronics instructor in the Signal Corps and as a research engineer at the military laboratories in Lexington, Ky.

He succeeds Irving Kagan who resigned as secretary of the *Tel-O-Tube* organization.

* * *

RAY RICE, formerly director of publicity for *Raytheon Manufacturing Company*, died recently in New York Hospital of a heart ailment. He was 49.

A well-known figure in the radio industry, Mr. Rice served as an aide to Major General Karl Truesdell and as a Colonel on the staff of General Omar M. Bradley during World War II.

After his discharge from the army in 1945, Mr. Rice joined *Raytheon* and then a year and a half ago he opened his own public relations firm in New York. He was associated with the late humorist, George Ade, for almost twenty years beginning his public relations career with Mr. Ade upon his graduation from college.

* * *

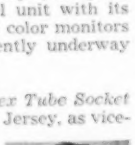
COLUMBIA BROADCASTING SYSTEM and *Remington Rand Inc.* have announced the signing of a cooperative agreement whereby the two companies will produce color television equipment for industrial, business, hospital, government, and military use.

Under the agreement *CBS* will provide the designs of the equipment, *Remington Rand* will manufacture and sell, *CBS* will perform the testing functions, and *Remington Rand* will then take over distribution and installation. Existing organizations of both companies will be used for the project. The equipment is designed to operate on the standards recommended by *CBS* to the Federal Communications Commission.

The newly designed equipment, to be marketed under the name of "Vericolor," will consist of a simple, compact, lightweight, single-color camera, a control unit with its own color monitor, and as many additional color monitors as may be required. Production is currently underway with delivery expected later this year.

* * *

HAROLD R. TERHUNE has joined the *Mycalex Tube Socket Corporation* of New York and Clifton, New Jersey, as vice-president and will head the standards department of both this company and its affiliate, *Mycalex Corporation of America*.



Mr. Terhune was previously associated with *Radio Corporation of America* where for the past six years he has been in charge of electrical components standardization for the *RCA Victor Division*. Prior to that he was with the *deForest Radio Company* and the *Hygrade Sylvania Corporation* in commercial engineering capacities covering tubes and components.

* * *

BENJAMIN OLNEY, director of research of the *Stromberg-Carlson Company* of Rochester, New York since 1937, has

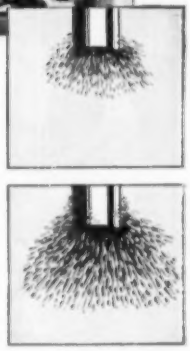
(*Continued on page* 118)

There's Real *SALES PULL* in these Facts about...
GENERAL ELECTRIC SPEAKERS!

IT PLAYS UNDER WATER! Submerged in water, the G-E speaker continues to deliver sound reproduction day in and day out. Do you know of any other speaker that will take a similar beating? The answer is in G.E.'s waterproof Voice Coil...the hottest selling feature in any speaker today!

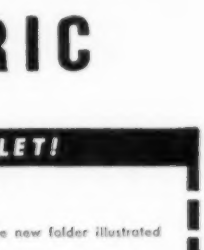
WHEN you're out to corral new business (and what smart dealer or serviceman isn't?) give yourself a head start by selling the line that's booming along today at a dollar volume 40% higher than last-year's record...

General Electric speakers—from the 4" replacement unit to the famous 12" high fidelity champion—are packed with features that assure your customer superb performance and build his confidence in your workmanship. You'll make no mistake when you stock, talk, and sell General Electric speakers!



GREATER MAGNETIC POWER. The stronger the magnet the more sensitive the speaker. Iron filing clusters indicate comparative magnetic strengths...the Alnico 5 alloy used in G-E units is 2½ times as powerful as the standard material previously employed in magnet construction.

ALL WELD CONSTRUCTION. Rigid enough to support a man's weight, the G-E speaker housing is treated with bright-finish zinc plating...this enables the speaker to resist corrosion long after untreated models have begun to rust.



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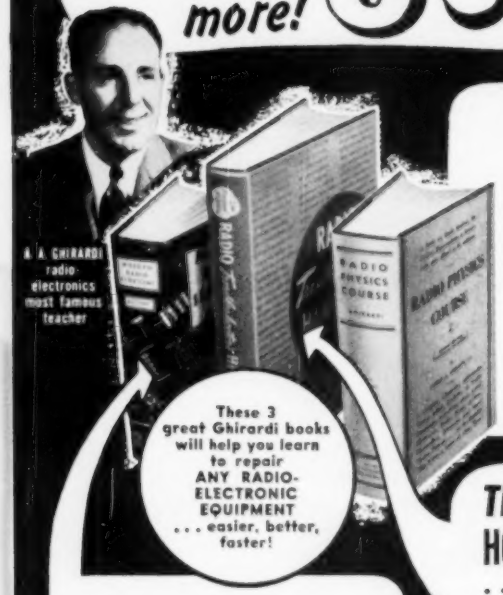

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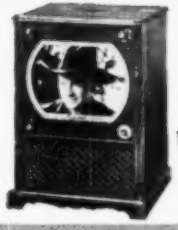

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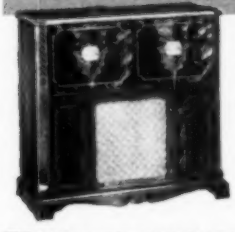

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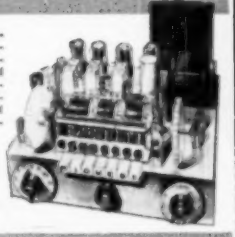

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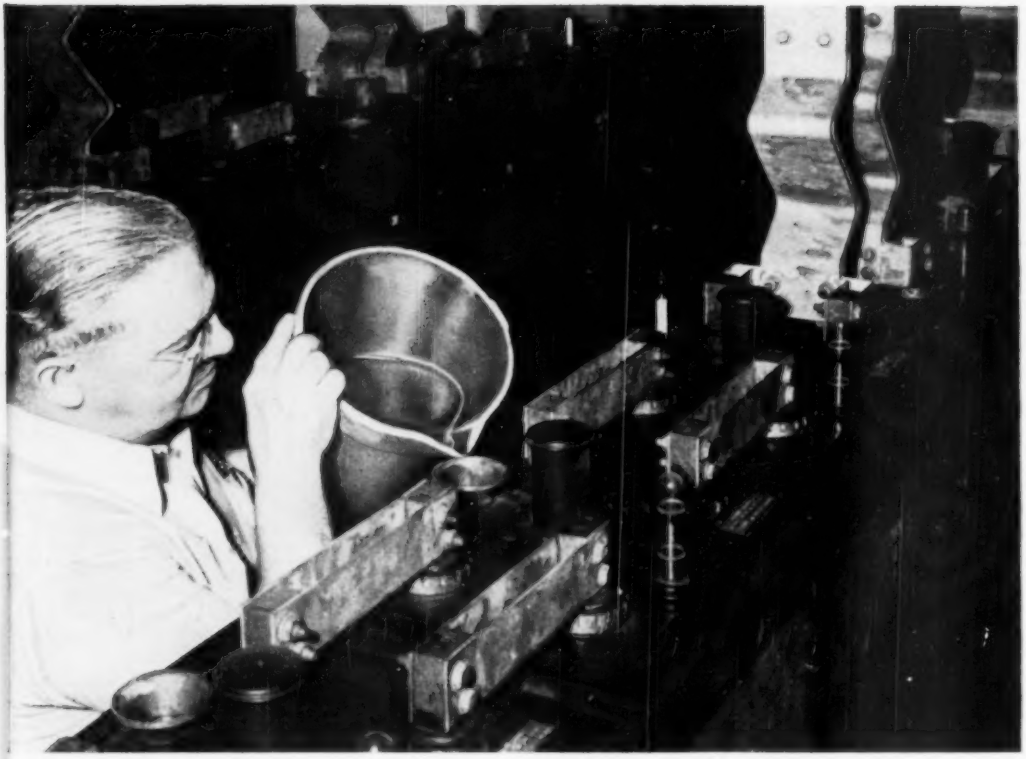

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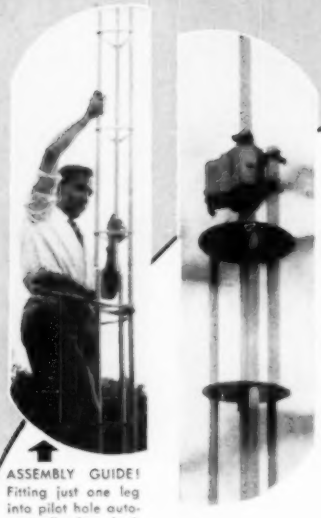

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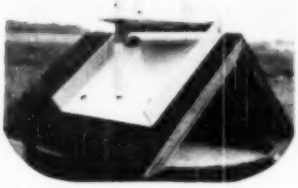

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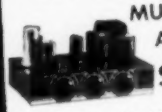

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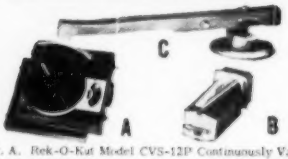

Fig. A. Rek-O-Kut Model CVS-12P Continuously Variable Speed Turntable that plays any RPM from 25 to 100 without wow. Ideal for use in schools, dance studios, broadcast stations, etc. Constant speed, 4 pole motor with internal rim drive. 12" cast aluminum turntable. Noise lever -30 db. Size 16 x 12", 1-1/2" above chassis, 4" below. Housed in portable case. Complete with 16" pickup arm and dual stylus cartridge. For 105-125 V., 60 cycle AC.

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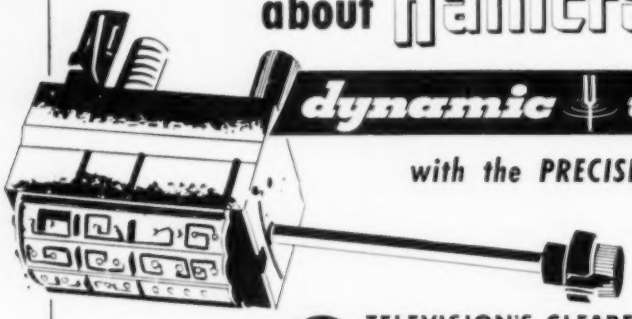

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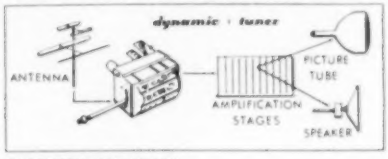

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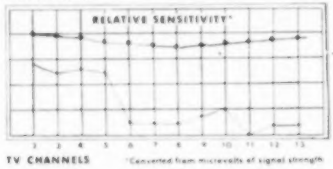

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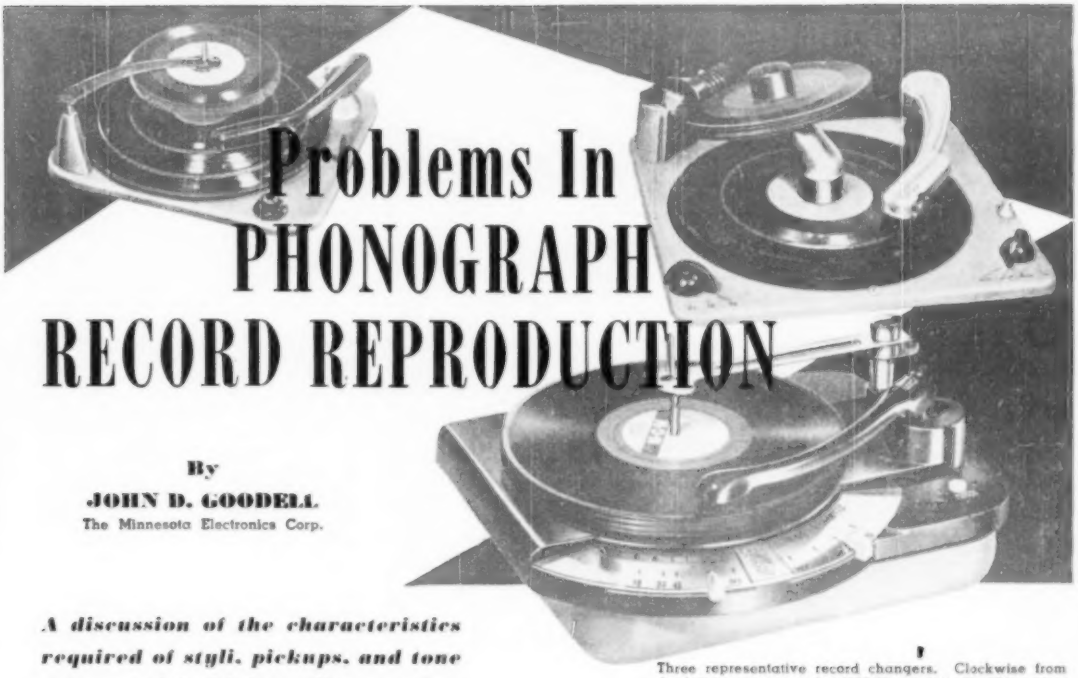
Problems In PHONOGRAPH RECORD REPRODUCTION

By
JOHN D. GOODELL
The Minnesota Electronics Corp.

A discussion of the characteristics required of styli, pickups, and tone arms used in high-quality systems.



Three representative record changers. Clockwise from the left hand corner: the V-M Model 950, the Milwaukee Stamping Company's Model 11600 unit, and Zenith's new "Cobra-Matic" with variable speeds from 10-85 r.p.m.

A MUSIC reproducing system is a chain of elements, and nowhere is the old saying about the weakest link controlling the system more valid. This article has to do with the first links in the chain of record reproducing components: the stylus, the pickup, and the tone arm structures.

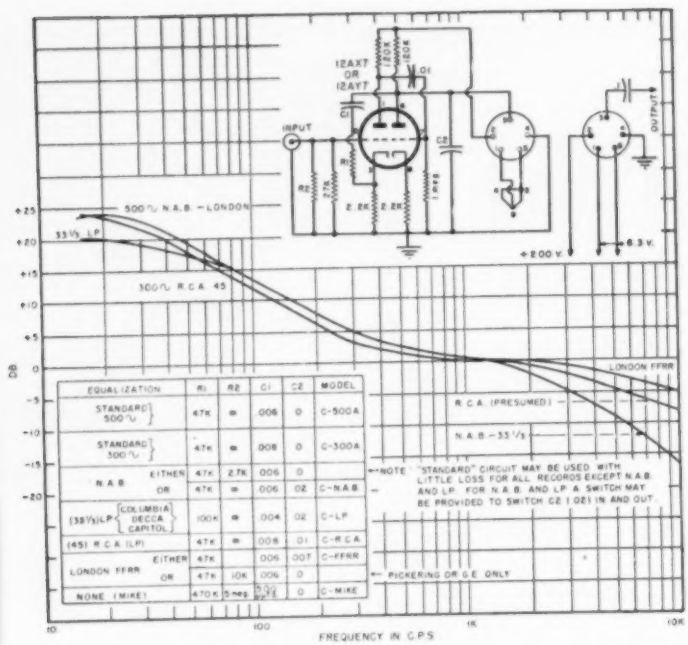
The earliest element in the signal input section is the stylus, and its importance is appreciably greater than is realized by most engineers and technicians. The stylus has the task of traveling a road that is tortuous, complicated, and replete with unbelievably sharp turns. It is required to course along this path at high speeds, maintaining perfect contact with the sides of the road at all times, accepting the friction and shock involved with changing direction 10,000 times per second and simultaneously traveling at a rate of forty or more inches per second along the groove. Its total travel, of course, includes the complex side trips involved in the modulation. Where long playing microgroove records are involved, the turns are sharpened and crowded together to the point where a careful examination of the problems would lead many to believe that it just isn't a practical way to reproduce music.

Obviously it is essential that the fit between the stylus and the groove be as perfect as possible. With microgroove records the dimensions involved are extremely small, and not only the over-all shape of the stylus but the very texture and polish of the surface are of real importance. Studying these problems leads to the conviction that nothing less than a perfectly polished diamond is really satisfactory for the purpose. As a practical matter, for general purpose applications sapphire and even osmium and other metal alloys may be used. For playing records of popular tunes that will soon be discarded in any event, they are not too unsatisfactory.

The damage done to the stylus by friction with abrasive dust in the grooves is more serious than is generally realized, and happens much faster than might be expected. In tests where microgroove records have been played with ideal equipment in air conditioned, dust-free chambers, the life of diamond styli and records has been shown to be many thousands of hours. Using the same equipment in ordinary atmospheres the normal accumulation of abrasive dust may shorten this to a thousand hours or less, even for a diamond stylus. When other factors are included, such as poor bearings in the arm, vibration in the turntable, etc., the life expectancy of any stylus is greatly shortened. It becomes clear that a factor of primary importance in preserving both styli and records is minimizing of abrasive dust. With plastic materials such as vinylite which are used for all long playing types, very high electrostatic charges are developed by frictional contact with the record envelope, the turntable, and the actual playing of the record. The use of an anti-static agent designed for the purpose is of considerable value in eliminating the problem of dust attracted to the record surface by these charges.

It is interesting, and not generally known, that shellac records are inherently capable of greater crispness at the high frequency end than are the plastic types. The reason is that the shellac is hard and relatively brittle, and it presents a surface to the playback stylus that does not permit it to deviate from the path originally traced by the cutting stylus. Vinylite records have considerably more elasticity, and under the heavy pounding of high frequency, high modulation passages the sides of the grooves will deform, permitting the stylus to slide by without tracing the complete brilliancy of the original master. The shellac records, on the other hand, suffer from breakdown of the walls of the groove and small particles of shellac and abrasive dust are poured into the grooves, later to be ground in by repeated travel of the stylus with resultant increases in noise level. Fortunately, vinylite has an excellent elastic memory and the deformation of the walls is only temporary so that these effects are not cumulative.

It is important to remember that in



EQUALIZATION		R1	R2	C1	C2	MODEL
STANDARD 500 ~		47K	∞	.006	0	C-500A
STANDARD 300 ~		47K	∞	.008	0	C-300A
N.A.B.	EITHER	47K	27K	.006	0	
	OR	47K	∞	.006	.02	C-N.A.B.
(33⅓) LP	COLUMBIA, DECCA, CAPITOL	100K	∞	.004	.02	C-LP
(45) R.C.A. (LP)		47K	∞	.006	.01	C-R.C.A.
LONDON FFRR	EITHER	47K		.006	.007	C-FFRR
	OR	47K	10K	.006	0	
NONE (MIKE)		470K	5 meg	.0025	0	C-MIKE

Fig. 1. Diagram of the Goodell plug in preamp equalizer and associated equalization curves.

pounds-per-square-inch the six grams ordinarily recommended for long playing stylus pressure corresponds to approximately an ounce of pressure on standard styli. A very small deviation in total pressure produces a very large change in pounds-per-square-inch, and it is well worthwhile to take the trouble to adjust the stylus pressure to as low a value as is consistent with satisfactory tracking of the grooves. If the pressure is too low it will, of course, allow the stylus to rattle against the walls of the groove with equally disastrous results. It is probably better to err slightly on the too heavy side rather than using too light a pressure because most arms, most turntables, and many records have inherent faults that operate to increase the problems where too light a pressure is used.

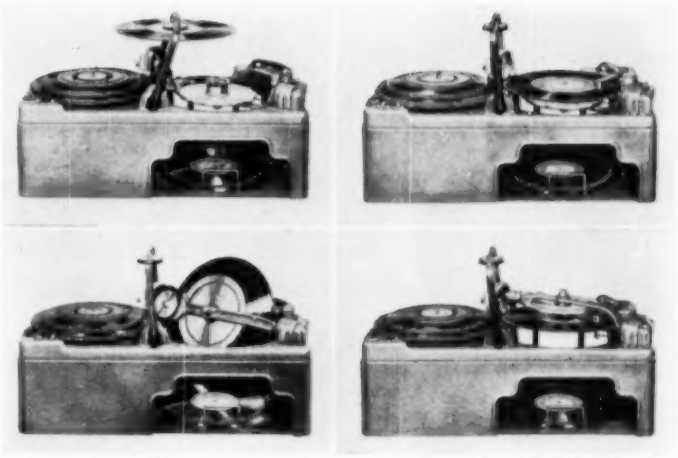
With most record changers it is very important to adjust the angle of the stylus with respect to the groove in such a manner that the deviation from normal is averaged over a stack of records. A problem that is not generally given sufficient consideration is the matter of the stylus dropping on the record surface when the arm is released by the changer mechanism. Careful adjustment to minimize this is well worthwhile, not only because of possible damage to the stylus but also because continued dropping often deforms the cantilever spring suspension of magnetic cartridges and some crystals. In many installations where little attention is paid to this factor, the servicer technician will find the lower surface and even the sides of the cartridge case worn down from contact with the record as a result of the fact that the stylus has gradually receded from continued shock. One excellent solution to this is found in the design of the *Lincoln* changer. This mechanism was designed by engineers of a firm that specializes in the manufacture of grease guns and similar equipment. Logically, when they set to work to design a record changer they operated everything possible by pneumatic means. It is an advantage that only one record is on the turntable at a time, but in addition to this the stylus is gently lowered to the surface by a pneumatic valve, and there is no mechanical shock.

Considerable experimental work has been done with the shape of stylus tips and a few investigators have reported improved results with a slightly oval shaping. Others have concentrated on producing an all-purpose design that may be used for both standard and long playing records. It is the tendency of the engineer to strive for perfection, but it must be borne in mind that the general public is often willing to accept a considerable compromise with such perfection if increased ease of handling is a factor. It's a nuisance to change cartridges or styli in going from one speed to the other. For people who use music as a background for other activities where they are not listening critically to the details of performance, the general purpose stylus is probably a valuable contribution. With a stylus that is too large for the microgrooves there will be some loss of high frequencies and some increase in record wear, but in some applications and for some listeners the loss of highs is of no consequence and the increase in wear may not be considered serious. With standard records the slightly too-small stylus will rattle and produce distortion at high frequencies, and again the lasting properties of both record and stylus will suffer. There is little doubt that the large grooved records will eventually become museum pieces and this problem will vanish, but it will be a good many years before such a changeover will be complete.

The problem of equalization for various records is still with us, and will be for quite a while, but there appears to be an excellent chance that the various manufacturers will strive to set and maintain standards that will eliminate this before too long. The difference in equalization curves has perhaps been over-emphasized at times in the literature. It will always be true that the acoustic conditions under which the recording is made will exert an equal or greater influence over the frequency response characteristics of the record than the electrical equalization curves in the recording equipment. Although most manufacturers of pickups go to considerable trouble to provide the customer with circuits and methods of suitably terminating the cartridge for optimum equalization, a great deal of this material goes unread. Continually letters are received from users of magnetic cartridges who complain that the high frequency response on long playing records is excessive, and it is found that they are terminating the pickup in the same resistive load they have always used for the standard cartridge. The resistive load into which either a crystal or magnetic cartridge works makes a very large difference in its response characteristics. In general, the low frequency response of a crystal increases directly with an increase in the size of the terminating resistor. Conversely, the high frequency response of a magnetic cartridge goes up with increased size of the resistive load. One of the factors that continually confuses the novice in working with magnetic cartridges is the matter of shunt capacitance. It has been the practice for so long to think of designing simple high frequency tone controls with a capacitance that shunts some portion of the signal circuits, and to worry about shunt capacitance in the wiring diminishing the high frequency response, that the misunderstanding of the problem is not strange. Actually, with magnetic cartridges a shunting capacitance in the range of values normally used for this purpose will resonate with the coil of the cartridge to produce a high frequency peak. It is for this reason that it is important to keep the shielded lead from the pickup to the preamplifier as short as possible. Where there is inadequate high frequency response as a result of the cartridge or stylus design, it is sometimes practical to insert a small ca-

pacitance and produce a peak at the high end with desirable results. The order of magnitude for the condenser will usually be in the range between .0005 and .01 μfd., but this will vary greatly with the various types of cartridges and the characteristics of associated wiring and circuitry. These simple principles may be used to change the response characteristics of either type of cartridge within very wide limits. Most microgroove magnetic cartridges should be terminated in approximately 2500 ohms for proper equalization of the average long playing recording characteristic at the high end. Where the input resistance of the preamplifier used for playing standard records is approximately 30,000 ohms, a shunting resistor directly across the terminals of the long playing cartridge of approximately 2700 ohms will solve the problem. A quarter-watt resistor may be easily soldered directly on the terminals of plug-in cartridges. With preamplifiers that actually have the proper amount of low frequency boost for standard records, the low frequency response from microgrooves may be excessive. Most preamplifiers do not have sufficient equalization at the extreme low end for standard records. Usually this may be corrected in either direction by slight adjustment of the low frequency tone control.

A considerable amount of material has appeared in recent articles in various publications regarding the Fletcher-Munson hearing curves. These curves show that both the low and high frequency response of the ear falls off at low volume levels. This is a phenomenon that has been known for many, many years, and as long ago as 1930 commercial radio-phonographs used compensated volume controls to make up for this low volume deficiency in hearing. Obviously, if it is desired to reproduce in miniature form the subjective sensation that is involved with full scale performance, it is desirable to boost both bass and treble in order to compensate for hearing characteristics. However, if this is done with an automatically compensated volume control it means that the operator of the equipment is married to the compensation arbitrarily inserted and he can almost never produce a flat curve at low levels. Fixed electrical compensation of this kind does not take into account the characteristics of the loudspeaker or the input signal. It does not allow for the acoustic conditions in the room or the enormous variations in individual hearing and individual subjective concepts of good reproduction. It seems far better to produce a flat basic electrical response and provide tone controls that may be adjusted by the listener to produce optimum results. Again it must be recognized that there is some convenience in the automatic device, and perhaps for the uncritical listener it is a convenience. If such a device is to be used it should at least be inserted only when it is designed specifically in terms of the entire system. Otherwise such factors as loudspeaker efficiency, which varies over extremely wide limits, will completely upset the validity of the automatic compensation curves.



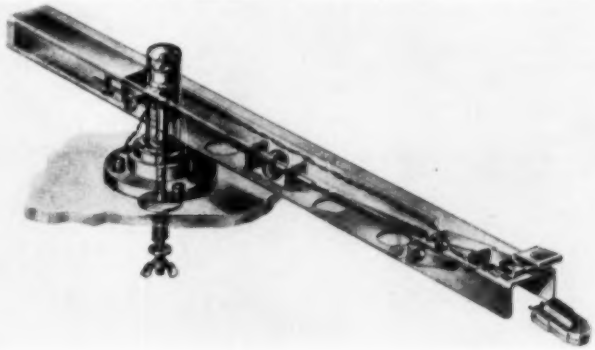
Four views of the Lincoln record changer "in action." (Upper left) The record is placed on the turntable and the first side is played (upper right). The turntable inverts (lower left) and the second side of the record is played (lower right). After second side has been played the record is released to the receiver and the cycle repeats automatically. If the changer is set for "single side" operation, it releases the record without playing the second side. This Series 50 record changer will handle all speeds and sizes of records. Any size and thickness of records of the same speed are handled automatically and may be intermixed in any sequence. Rubber suction cups handle the record and only one record is on the turntable at any one time.

For those readers who are interested in building preamplifiers for magnetic pickups, a circuit is shown in Fig. 1 with a variety of values given for matching various standard recording characteristics. In some instances there is a choice of two methods for achieving substantially the same results. The values that are changed to obtain different equalizing may, of course, be connected in suitable switching arrangements for convenience of the critical listener. As a practical matter, few people find that they actually use such facilities to any great extent.

The subject of tone arms is an important one, and the problems are not too widely understood. The tone arm must support the cartridge, provide the necessary mass for the stylus to work against and permit smooth tracking across the record surface. If records and turntables were manufactured within sufficiently close tolerances, and if records did not warp, then the problems would be greatly simplified, and a tone-arm designed with extremely high mass and good lateral bearings would provide a completely satisfactory device. Unfortunately there are many factors that make this an incomplete and unsatisfactory solution. To begin with, it is important that the arm be free to move vertically in order to track warped records and turntable wob-

(*Continued on page* 154)

The Pickering Model 190 pickup arm. This arm, used in connection with the proper pickup cartridges, is capable of playing both standard and microgroove recordings. The correct pickup can be plugged into place without weight adjustment, screws, or wires.



A Flexible RECORD-REPRODUCE SYSTEM

By
OLIVER READ
Editor, RADIO & TELEVISION NEWS

Part 1. A new series of audio articles devoted to complete systems using "studio" methods.

THERE are many audio engineers, students, home-recordists, and dyed-in-the-wool enthusiasts who show a keen interest in "customized" audio installations. Generally these men are also interested in setting up complete record-playback systems for the purpose of making audio measurements, for comparative testing, and for the high quality reproduction of music.

The above category includes both those who prefer to build their amplifiers, tuners, and mechanisms and those who choose their equipment from the manufacturer's ads and catalogues.

Numerous articles have appeared in this and other publications, giving complete data on the construction and design of equipment for the recording and reproduction of sound. Our own experience in "rolling our own" has been most enjoyable and satisfying. However, there are many who do not have the time nor desire to build their own audio equipment.

So many requests have been received for information on how to employ commercial audio equipment in complete systems that we have gathered representative units and set to work on a really flexible system, easily duplicated by the average audio man. By using techniques employed in recording studios this system provides numerous combinations, circuitry, and gives superior performance. All of the equipment shown was formerly in use but scattered in random fashion around our laboratory.

Several innovations were required in the physical layout to make all equipment accessible from the front of the installation. We found that a double rack assembly would fit perfectly into a small area between two built-in consoles. Each rack would mount several pieces of equipment, including a 16" television tuner.

To meet our own requirement for recording and reproduction on disc and tape, we decided to incorporate the following equipment:

1. A preamplifier with five selective inputs and with self-contained variable equalizers.
2. A line amplifier.
3. Two jack panels.
4. A 50 watt recording and playback amplifier.
5. A 10 watt monitor amplifier.
6. A spare record-reproduce amplifier, with built-in dynamic noise suppressor.
7. An FM-AM tuner with built-in audio preamp and equalizers.
8. A 16" television tuner.

Sectional view of the author's recording studio, laboratory, and television viewing center built into the walls of a den.

9. Two speakers on two separate 600 ohm lines.
10. A two-speed tape recorder with monitor.
11. Dual 16" turntables for recording and playback.
12. Volume and power level meter panel.
13. A d.c. supply for meter illumination and certain filaments.
14. Provision for several phonograph pickups of various types.
15. A 3 watt amplifier for the television tuner.

You will note the absence of a conventional mixer panel. This was deemed unnecessary since the preamplifier on hand had adequate provision for the limited amount of mixing that would be required in this particular system.

The Preamp-Equalizer

Our first requirement was satisfied by employing a *McIntosh*, Model AE-2 preamplifier-equalizer control unit. This was originally designed to provide an adequate amount of amplification between five different program

sources and a recording or reproducing amplifier. Various program circuits are selected by means of a front panel control labeled "Selector." Five input channels are provided. Circuits 1 and 2 receive 40 decibels of amplification, constant from 20 cycles to 20,000 cycles.

Circuits 3 and 4 receive 40 decibels of amplification, constant from 1000 cycles to 20,000 cycles (but increases below 600 or 300 cycles to compensate for the 6 decibel-per-octave recording characteristic). A choice of either turnover frequency (600 or 300 cycles) is selected by a switch on the panel.

Circuit 5 receives 70 decibels of amplification which is constant with respect to frequency. All five circuits are subject to variable amounts of bass and treble boost or bass or treble attenuation. The two controls are noninteracting and provide a boost up to a maximum of 17 db. and attenuation to a maximum of 17 db.

The first two channels are intended to be used between such program sources as crystal microphones or pickups and FM-AM tuners. In order to prevent overloading at the inputs of these two channels, separate potentiometers are provided which may be used to preset the program level in those two circuits.

Circuit 3 presents a 27,000 ohm load and is designed to provide flat frequency response from the high impedance *Pickering* cartridge. Circuit 4 likewise presents a 12,000 ohm load which provides substantially flat response from the *G-E* variable reluctance cartridge. Where circuits 3 and 4 are used with magnetic cartridges of other manufacture, such as the new *Audax*, the terminating resistance may be removed and the optimum value substituted, as recommended by the manufacturer.

A bird's eye view of the two disc recording and playback channels. Ample storage space for the processed transcription discs is provided in the cupboards below.

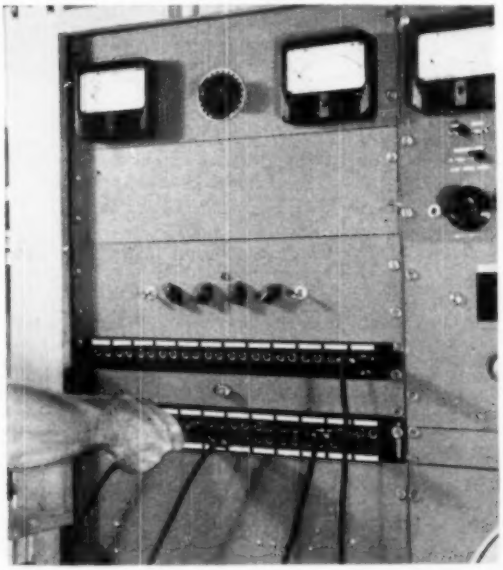
Circuit 5 provides 70 decibels of amplification and loads the program source with ½ megohm resistance shunted by approximately 16 $\mu\mu$fd. of capacity. This circuit provides adequate amplification for nearly all high impedance magnetic type microphones.

The two equalizer controls are used to modify the frequency response of the preamp on each of the five program circuits. In the case of circuits 3 and 4, the 6 decibels-per-octave change in amplification below 300 or 600 cycles, may be either increased to 12 decibels-per-octave or reduced to almost a constant amplification with respect to frequency.

It was necessary to modify the output circuit of the preamplifier to meet our own particular requirements. Normally the parallel-connected 12AX7 tube is used in a cathode follower circuit and feeds directly to the power amplifier. We added an output transformer to match the output imped-

(*Continued on page* 135)

All of the program sources, the metering circuits, and the outputs of the entire system terminate in this jack field.



Convenient hinged panels give easy access to the amplifiers used in recording and monitoring the program material.

Devotees of high-quality reproduction are buying the individual audio components and housing them in cabinets such as these Jensen "Custom-Mode" units.

How To Judge AUDIO QUALITY

By JOSEPH MARSHALL

In the final analysis, it is the "subjective listening test" which really tells the story.

SO, YOU'VE finished that super-dooper high fidelity amplifier and now you want to know how good it really is. You can, and no doubt you do, make some frequency runs and some distortion measurements and perhaps look at some scope patterns. But the proof of the pudding is in the eating and of a high fidelity sound system is in the listening. All authorities agree that in the final analysis it is the "subjective listening tests" which really tell the story. But how do you go about making such tests? What are the criteria for a *good* amplifier? In other words, you ask: "How do I know when I listen that my amplifier is as good as I hope it is? What do I use for test material? What are the characteristics of a good system? What do I listen for?"

The General Effect

Let's dispose of one thing to begin with, namely: *there is no necessary connection between perfect reproduction and fidelity and the adjectives "pleasant and mellow."* Much of the confusion in the high-fidelity field results from a tendency on the part of those who have little or no experience with, or knowledge of, music to judge reproduction in terms of the question: Does it sound pleasant or not?

Good music is pleasant, more often than not, but it is not pleasant because the tone is entirely pleasant. There are many elements of great music, played magnificently, which are definitely on the unpleasant side from a tonal standpoint. On the other hand, it is very probable that the tone of a cheap table model radio, operating at low volume levels, with its limited frequency response, masked distortion, and mellow tone, is more pleasing to most ears than the Philharmonic Orchestra in person. In high fidelity reproduction we are not trying to improve on the original material, but merely to recreate it with the greatest faithfulness. So let's start by forgetting those words "pleasant" and "mellow." They do not necessarily apply to high-fidelity reproduction; and, on the contrary, are often characteristic of systems of low fidelity.

That does not mean that high-fidelity reproduction must be unpleasant. It is true that too often in the past it has been highly unpleasant for the simple reason that inadequate systems have added more unpleasant elements to the original than the ear could tolerate. And this brings us to the first and one of the most important criteria of a great sound system: *The over-all effect must not be painful.*

Great music well played, even the dissonant modern music, is not painful although it may be unpleasant at first hearing. It doesn't actually hurt the ear, produce headaches, uneasiness and nervousness. Bad high-fidelity systems are very painful, *literally* painful. Listened to for long periods they do produce headaches and a squirmy unease, a firm desire to pull the switch and stop the noise.

The term "fatigue factor" is now finding its way into acoustic terminology and refers to this tendency of poor sound systems to cause pain and fatigue in listeners. Fatigue is caused principally by excessive distortion. The lower the distortion, the lower the fatigue factor. Therefore, for the most critical listening test of all, feed your sound system high fidelity program material and keep it going, at a slightly higher than normal volume level, for stretches of 5 or even 10 hours, while you and your family go about your normal business.

If you and your family can stand listening to it many hours at a stretch without getting irritable or headachy, you are on the right track. But if the amplifier does make people irritable, or gives them headaches; if they ask after so long to have it shut off, or simply beat it out of the house, the chances are that it isn't because they don't appreciate the finer things of life, but because your amplifier has too much distortion and too high a fatigue factor.

High Frequency Response

Curiously enough, one of the mistakes designers make when listening to their first high fidelity amplifier, is to confuse distortion with high frequency response. When the new amplifier and speaker begin to emit sounds of indubitably high frequency and a lot of them, the constructor assumes he has achieved a great high frequency response. And so, to be sure, he has; for the distortion would not be so audible if the passband were narrow.

Actually the very fine high-fidelity system, at first hearing, appears to have less high frequency response than the poor system simply because it lacks distortion. And, lacking distortion, it actually has less high frequency amplitude in its output than the poor "high-fidelity" system.

It reproduces the very high frequency tones, but it reproduces them

(*Continued on page* 171)

A Two-Channel MAGNETIC RECORDING AMPLIFIER

Panel view of home-built amplifier. It can be adapted for public address work.

By
LLOYD B. HUST

Two complete amplifiers on one chassis designed to be used with separate recording and playback heads.

WITHIN the past few years, magnetic recording has become one of the most popular methods employed in the recording art. At first, this may seem strange in view of the fact that magnetic recording techniques were first explored more than 50 years ago. The recent popularity of magnetic recording has actually been brought about by a number of things. First, and probably foremost, is the technique of recording using a supersonic bias voltage mixed with the signal being recorded. This method of recording virtually eliminates the distortion and high background noise which was typical of early magnetic recorders. Second, the development of high permeability materials for use in magnetic recording heads has done much to raise the standard of such a method. Third, and definitely not the least, is the development of high quality recording materials, both wire and tape.

At the present time there are a number of good magnetic recording accessories on the market—wire and tape chassis as well as various types of recording, playback, and erase heads. However, there are very few experimental amplifiers on the market for magnetic recording.

Most of the tape and wire recorders on the market today are equipped with amplifiers of the "dual type." That is, they have one amplifier which functions as both a recording and playback amplifier. This has several advantages—low cost, compactness, etc., but it lacks the flexibility of a true two-channel amplifier.

The truly "professional" recorders—that is, those used for broadcasting, movie sound recording, etc., use two-channel amplifiers. One big advantage inherent in this type of amplifier is the opportunity it affords for monitoring the recorded material right from the wire or tape as the case may be. Another advantage with this type of amplifier is the possibility of having one type of equalization for recording and another for playback without the necessity for complicated switching circuits. Also, it becomes unnecessary to bring input and output circuits together in a switch with all the problems of feedback and hum that this practice entails.

The amplifier to be described is essentially two complete amplifiers mounted on one chassis with one power supply, but otherwise operating independently. One section is designed for recording only and is equipped with the proper equalizing circuits for this function as well as with the bias oscillator necessary for recording. The other section is designed for operation with the "play" head as the input device. The proper equalizing circuits for this function are provided. The amplifier was designed for use with separate recording and playback heads, but it can be used with a dual purpose head by simply connecting the head to the output of section one for recording and to the input of section two for playing back. For this reason similar connectors were used with the output of the recording amplifier and the input of the playback amplifier.

Switch S_1 has been added to permit the recording channel to be fed into the playback channel if it is so desired. This permits the unit to be used for limited public address work as well as for playing phonograph records.

Although the recording equalizer is not in the circuit when this switch is used, the equalization is so small that the signal is not greatly affected. This switch may be used for monitor purposes when recording on machines using only one head.

The unit was built on a 7" x 14" x 2" chassis with a 7" x 15" metal panel. The panel was given a stippled effect by treating it as follows: First it was rubbed down with steel wool. Then an ordinary pencil was chucked in a drill press with the eraser end down. With the machine running, the pencil eraser was brought into contact with the panel for an instant. The panel was then moved slightly and the operation repeated until the entire area of the panel had been covered. This will work well with either aluminum or steel panels and the result is a pleasing, mar-proof panel which enhances the appearance of the equipment.

EDITOR'S NOTE: *The recording and playback heads used were of the high impedance type. Indiana Model TD-701, Shure Model 815, and the head used on the Brush "Soundmirror" were all tried with equally good results. Identical heads were used for both recording and playback.*

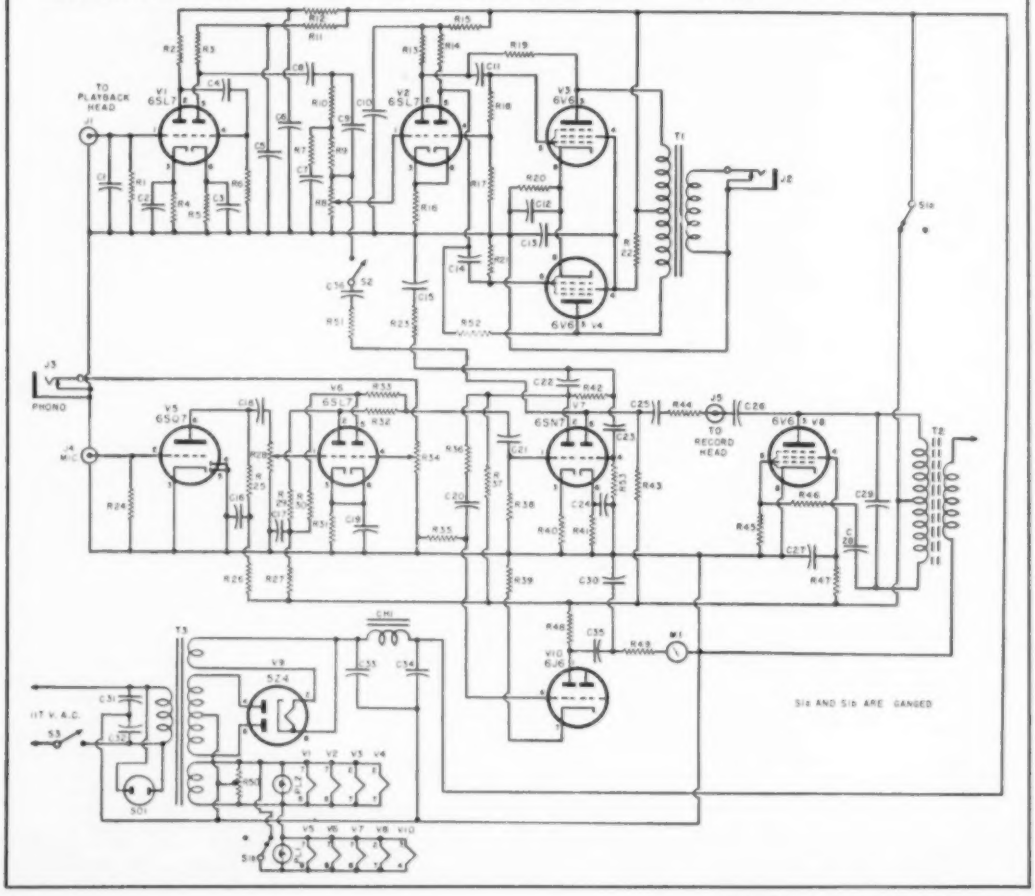
If desired, low impedance heads can be used with this amplifier. If this is done, the playback head should be fed to the first grid through a 50 ohm-to-grid input transformer. The record head should be fed from the output of the 6SN7 through an output transformer of the correct impedance to match the plate of the 6SN7 to the impedance of the head used. The bias, in this case, would have to come from the low impedance winding on the oscillator coil, and would probably be fed into a tap on the record head winding, depending on the head used.

The recording channel of this unit utilizes a 6SQ7 preamplifier which is resistance coupled to one section of a 6SL7 electronic mixer. The other section of this tube is connected to a jack which supplies a signal from a phono pickup or from a radio tuner. This circuit makes possible the mixing of the two inputs without the slightest sign of interaction. This mixer stage is then fed to one section of a 6SN7, from there through an equalizing network to the second section of this same tube from which it is fed through a .5 μfd. condenser and a 25,000 ohm resistor to the recording head. One thing will be apparent from the schematic of this section, i.e., that small values of cathode condensers are used and in the case of one stage, no cathode condenser is used at all. The reason for this is to help pre-emphasize high frequencies, a feature that is necessary for good magnetic recording.

For the recording bias, an oscillator using a 6V6 tube in conjunction with a *Webster-Chicago* oscillator coil is connected. The voltage from this oscillator is shunt-fed to the head through a 150 μμfd. condenser. It might be well to mention at this point, however, that this condenser, C_{36}, should be chosen to give the best value of bias flux at the recording head, and that its value should be increased if the bias is too low, or should be decreased if the bias is too great. The value is not critical, however, and the value given in the parts list seems to

Schematic diagram of the two-channel recording amplifier. Equalizing networks and bias oscillator are incorporated.

R_1, R_{10}, R_{20}, R_{28}—220,000 ohm, ½ w. res.
R_2, R_9, R_{29}—250,000 ohm, ½ w. res.
R_4, R_5, R_{31}, R_{32}—1000 ohm, ½ w. res.
R—15,000 ohm, ½ w. res.
R_7, R_{26}, R_{27}—500,000 ohm pot.
R_8, R_{13}, R_{21}, R_{30}, R_{35}—470,000 ohm, ½ w. res.
R_{12}, R_{15}, R_{18}, R_{23}, R_{33}, R_{39}—100,000 ohm, ½ w. res.
R_{14}, R_{17}, R_{22}, R_{40}, R_{48}—47,000 ohm, ½ w. res.
R_{16}, R_{19}—33,000 ohm, ½ w. res.
R_{24}, R_{41}—2000 ohm, ½ w. res.
R_{25}—15,000 or 22,000 ohm, ½ w. res. (See text)
R_{34}—200 ohm, 5 w. wirewound res.
R_{37}—5000 ohm, ½ w. res.
R_{38}—7500 ohm, ½ w. res.
R_{42}, R_{43}, R_{44}—1 megohm, ½ w. res.
R_{45}, R_{46}—25,000 ohm, ½ w. res.
R_{47}—150 ohm, ½ w. res.
R_{49}—68,000 ohm, ½ w. res.
R_{50}—3900 ohm, ½ w. res.
R_{51}—22,000 ohm, 1 w. res.
R_{52}—150,000 ohm, ½ w. res.
R_{53}—20 ohm, center-tapped wirewound res.
C_1—.002 to .01 μfd. paper cond. (See text)
C_{35}, C_{37}—50 μfd., 25 v. elec. cond.
C_{36}—10 μfd., 25 v. elec. cond.
C_{11}, C_{14}, C_{15}, C_{16}, C_{17}, C_{18}, C_{19}, C_{20}—.05 μfd., 400 v. cond.
$C_{21}C_{22}C_{23}$, $C_{24}C_{25}C_{27}$—10/10/10 μfd., 450 v. elec. cond.
C_3, C_{26}—.001 μfd., 400 v. cond.
C_{12}, C_{13}—150 μμfd., 500 v. mica cond.
C_{28}, C_{31}, C_{32}, C_{33}—.01 μfd., 400 v. cond.
C_{29}—.02 μfd., 400 v. cond.
C_{30}—.003 μfd., 400 v. cond.
C_{34}—.5 μfd., 600 v. cond.
C_{38}, C_{39}—.002 μfd., 400 v. cond.
C_{40}—.001 μfd., 600 v. mica cond.
C_{41}, C_{42}—.1 μfd., 400 v. cond.
C_{43}—C_{44}—20/20 μfd., 450 v. elec. cond.
S_1—D.p.d.t. toggle sw.
S_2, S_3—S.p.s.t. toggle sw.
J_1, J_2, J_3—Microphone-type closed circuit jack
J_4, J_5—Closed circuit phone jack
T_1—Output trans. 8000 ohm p-p to v.c.
T_2—Osc. coil (Webster-Chicago 65P024)
T_3—Power trans. 350-0-350 v. @ 125 ma.; 5 v. @ 2 amps.; 6.3 v. @ 4 amps.
CH_1—125 ma. filter choke
PL_1, PL_2—6.3 volt pilot lamp
SO_1—Female a.c. receptacle
M_1—+6 to −10 db. decibel meter
V_1, V_2, V_3—6SL7 tube
V_4, V_8, V_9—6V6 tube
V_5—6SQ7 tube
V_6—6SN7 tube
V_7—5Z4 tube V_{10}—6J6 tube



be right for most high impedance heads.

A necessity in any good recording amplifier is a good volume indicator. Since positive results can be had with a meter, the indicator chosen for this amplifier was a small decibel meter. It is easy to read and adjustments can be made for different types of heads or different kinds of tape which may require different recording voltages.

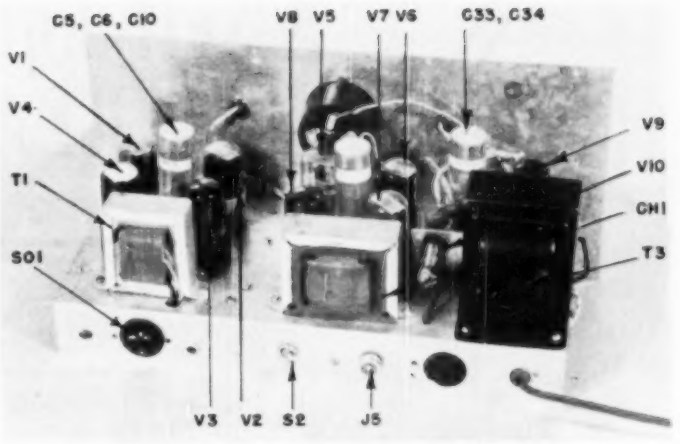
An annoying problem, as far as a volume indicator meter is concerned, is caused by the presence of the supersonic bias voltage in the circuit. Were it not for this voltage, we could simply connect the meter across the output of the amplifier and make the adjustments necessary for indication of proper volume level and that would be that. Not so with supersonic bias in the circuit. This bias voltage energizes the meter and gives a steady reading much higher than the fluctuating reading desired from the audio voltage, hence, we must isolate the audio voltage from the bias voltage.

In this amplifier this is accomplished by the use of a separate output stage for the meter. A 6J6 tube was used for this stage because of its size and because one was on hand. Almost any triode would suffice. This tube was mounted above the chassis in a horizontal position and its grid was energized from the *first* plate of the 6SN7. In this way a minimum of bias voltage reaches the grid. A small amount of this voltage does affect this tube, however, but this is bypassed out of the meter circuit by C_{10}. The resistor R_{28} determines, to some extent, the swing of the needle and its value may be raised or lowered to suit the situation.

The Playback Channel

The playback channel consists of a 6SL7 with the two sections in cascade, giving two stages of amplification. It may be necessary to shield this tube. The output from this tube is fed through an equalizing network to another 6SL7 which is used as a phase inverter feeding the 6V6 output tubes.

In this channel there are a few departures from standard practice which should be explained. First, the condenser, C_{11}, across the grid of the preamplifier stage is a condenser which should resonate with the head chosen, at some high frequency. This condenser gives the sharp high frequency boost which is required if anything approaching flat response is to be obtained with the amplifier. Its value will depend on the inductance of the head and the frequency at which boost is desired. This value can be found experimentally and the unit chosen should be the one which gives the best high frequency response with the head used. The value will usually be between .002 and .005 μfd. although it may be as high as .01 μfd. with some heads. As much as 6 db. boost can be obtained due to this resonating condenser. Another item which will be noticed is the fact that the volume



Top chassis view of amplifier shows the careful parts placement required.

control is not in the circuit until the phase inverter stage. This was done solely to minimize hum. The control and the equalizer circuit can introduce hum if they are in a low level stage and for that reason the control was introduced at the input of the phase inverter.

The equalizing portion of this channel other than C_7 is essentially a low boost equalizer and it is made up of R_{15}, R_{16}, R_{18} and C_7 and C_8. If greater low boost is desired as it may be with some heads, C_7 can be changed to 50 μμfd. If less boost is required, the value of C_8 can be increased.

Some question may arise in the constructor's mind about the feedback circuit used. Feedback is shown from one plate of the upper 6V6 to its grid. However, as this grid also feeds the other half of the phase inverter, feedback to both tubes is obtained.

If conventional feedback from both plates is desired, the resistor R_{29} shown dotted may be added. This will require the changing of R_{11} to a 22,000 ohm, ½ watt size.

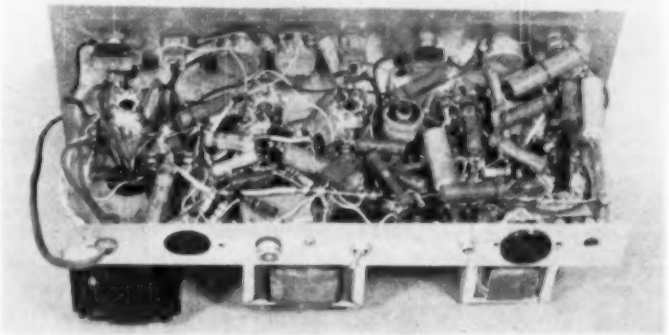
Both of these systems work about the same and the distortion suppression is about the same.

The output jack J_3 is mounted on the rear chassis lip next to SO_1.

Since hum-free operation of both channels was a prime necessity, pains were taken to minimize hum in every way possible with the exception of the operation of the heaters on d.c. The chassis was not used as a common grounding point, but a bus of #12 wire was run the length of the chassis and was mounted on insulated tie posts. This bus was used as the ground throughout and was connected to the chassis at one point only. Practices vary on the grounding of such a bus, but in this unit it was grounded to the chassis at the point where the center tap of the high voltage winding of the power transformer was brought to ground. All plugs, etc., were insulated from the chassis and panel by the use of fiber washers and *all* grounded points were run to the bus. Any shielded wire used—a minimum

(*Continued on page* 143)

Under chassis view of the magnetic recording amplifier. A common ground bus was used, being connected to the chassis at only one point where the center tap of the high voltage winding of transformer, T_1, was grounded.



A Self-Equalizing PREAMP

Front view. Power for this unit may be obtained from any convenient remote supply.

This unique circuit automatically compensates for "Fletcher-Munson" effect. Reproduced sound will seem natural irrespective of output level.

By
J. CARLISLE HOADLEY*

THE amplifier design trend today is toward providing a power amplifier section with heavy negative feedback and a frequency characteristic which is flat from some low frequency to well beyond audibility. These amplifiers approach theoretical perfection in linear amplification but fall far short of perfection in actually providing high fidelity results when called upon to drive a loudspeaker from a signal source. The fault does not lie in the amplifier, however, but in the loudspeaker's deficiencies in certain frequency ranges, and in the human hearing mechanism.

The loudspeaker is capable of efficient radiation of sound down to a frequency where the physical length of the sound wave is in the same order of magnitude as the diameter of the speaker's cone. Below this frequency, the speaker has successively greater difficulty in radiating sufficient low frequency energy, due to poor coupling to the air.

This situation is modified somewhat by placing the loudspeaker in an enclosure which, by one device or another, attempts to match the acoustic impedance of the speaker to the acoustic impedance of a room.

It is possible, at relatively low sound levels, to electrically equalize a speaker system so that it will reproduce frequencies as low as 40 c.p.s. at the same intensity as 1000 c.p.s. This equalization can be provided by the usual bass boosting circuit, but will still be inadequate. At normal listening levels, the low frequencies will still seem weak or non-existent.

The human ear has several characteristic peculiarities. Among these is the "Fletcher-Munson effect." This effect is characterized by a change in sensitivity of the ear to frequency extremes with a change in sound level. It is most pronounced at the low frequencies, *i.e.*, the ear sensitivity falls off quite rapidly as the sound level is reduced below the 100 db. level. There is a similar but smaller change in ear sensitivity at the frequencies above 8000 cycles per second. In listening to natural sound sources, this "Fletcher-Munson effect" is of no consequence, since we have interpreted sounds modified by this frequency characteristic since birth.

For instance, as we move closer to an orchestra, the level in db. presented to our ear drums increases. Normal hearing response is very nearly flat at a level of approximately 100 db. As a listener moves away from the musical sound source, however, the lower frequencies attenuate more rapidly than those of the middle range. Therefore, by sitting at the rear of an auditorium during a concert, the listener does not receive the same balance of high and low frequencies that he would experience if sitting in the front row.

When the orchestra is "picked up" with a microphone for radio broadcasting, the microphone is placed near the orchestra to obtain a good acoustic signal-to-noise ratio. In his home, then, the listener would have to operate his reproducing system at the same level (approximately 100 db.) as the orchestra for a natural reproduction.

It is when the normal level of the original sound is changed that the trouble begins. When listening to reproduced music at the 100 db. level where the human ear has a flat frequency characteristic, the music will sound perfectly normal (presupposing a flat audio system). Since the sound level produced by a 100 piece orchestra (100 db.) would be too loud for the average living room, there will be a desire to lower the volume. The volume is reduced, therefore, until the sound is reproduced at a level of 70 db. As far as the ear is concerned, the listener has moved several hundred feet from the sound source, and the reproduced sound has exactly the same character as if he had done just that.

Suppose our hypothetical listener did not wish to move away from the orchestra, but had intended to have the orchestra play at a level more consistent with his mood and place of listening. He will, therefore, instinctively reach for a bass boost control to bring himself closer to the music. When the bass has been boosted, the orchestra will seem close but playing softly. If music is required as a background for conversation, we would naturally have a desire to reduce the low frequencies to a point where the music seems to come from a distance.

This interesting ear characteristic and various listener preferences for different listening levels are responsible for the "tone control" circuits in amplifiers and radio receivers.

An understanding of why we want tone control is necessary for intelligent design of tone equalizer circuits. It would be a great convenience if the listener could concentrate on enjoying the music rather than laboriously adjusting and re-adjusting the tone control circuits with each change of the volume control.

There are several ways to change the response of the audio system with a change in loudness level. Some have been described in this magazine, and there is at least one such control commercially available. The idea is not new.

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The equalizing amplifier to be described is a somewhat different approach to the problem and has several refinements not found in some other systems. The curves in Fig. 2 show the amount of correction required for the low frequencies for the levels from 60 db. to 100 db. The 60 db. level is lower than anyone would run an audio system, and is too low a level for listening to a play or a news report if the listener is ten or twelve feet from the speaker. The noise level in an average living room is approximately 55 db. (windows open, summer).

The 100 db. level is as loud as a full symphony orchestra with the listener in the position of the conductor. These corrections are based on an average listener. The individual's ears may vary considerably, as well as his taste. The loudspeaker, audio system, and source of the sound will also modify the amount of equalization, *i.e.*, an old 78 r.p.m. recording might need more boosting than a live FM program. Controls are, therefore, provided to compensate for the individual situation, and, then, the unit automatically varies the response as the volume control is changed.

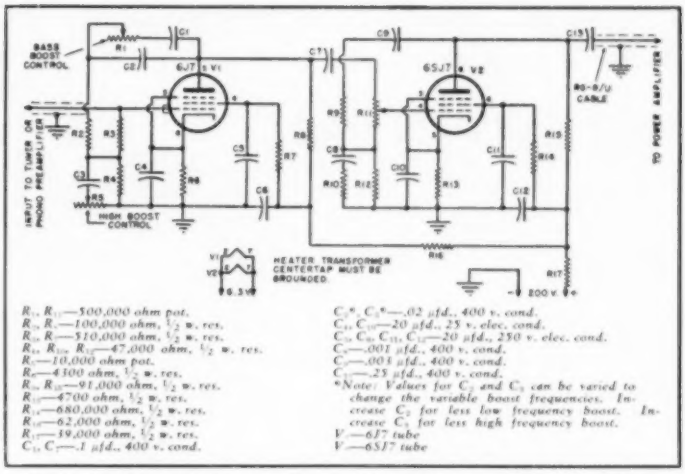
The circuit diagram appears in Fig. 1. The unit consists of a two-stage pentode amplifier. Pentodes were used because of their high gain and lack of "Miller effect." Since the two feedback loops are each applied around only one stage, each pentode is necessary to provide sufficient gain for the required equalization. At low levels, the pentode is virtually distortionless and the excellent shielding afforded by the metal tube shells helps to keep hum at a minimum. The 6J7 was used as an input tube because of the grid being well isolated from the heaters.

One of the feedback loops is applied from the plate of the 6SJ7 tube to the junction of the lower end of the volume control and a resistor between this point and ground. This circuit constitutes a feedback loop where the amount of feedback is variable depending on the setting of the volume control.

When the volume control is in the "Max." position, there is a high resistance between the feedback circuit and the tube's grid, and only a small amount of feedback is applied around the tube. As the volume control is turned toward the "Off" position, it successively reduces the resistance in the feedback circuit. At the minimum position there is no resistance between the feedback circuit and maximum feedback is obtained.

A reactive network is included in the feedback loop so that the low frequencies are not fed back as much as the higher ones. The low frequency crossover point is about 500 cycles per second. The high frequencies are also varied slightly at a crossover of approximately 8000 cycles per second.

The circuit is, in effect, one where the gain at different frequencies is varied at different rates as the volume



R_1, R_{11}—500,000 ohm pot.
R_2, R_{13}—100,000 ohm, ½ w., res.
R_3, R—510,000 ohm, ½ w. res.
R_4, R_{12}, R_{15}—47,000 ohm, ½ w. res.
R_5—10,000 ohm pot.
R_6—4500 ohm, ½ w. res.
R_7, R_{16}—91,000 ohm, ½ w. res.
R_8—4700 ohm, ½ w. res.
R_9—680,000 ohm, ½ w. res.
R_{10}—62,000 ohm, ½ w. res.
R_{14}—39,000 ohm, ½ w. res.
C_1, C_7—.1 μfd., 400 v. cond.
C_2*, C_3*—.02 μfd., 400 v. cond.
C_4, C_5—20 μfd., 25 v. elec. cond.
C_6, C_9, C_{11}, C_{12}—20 μfd., 250 v. elec. cond.
C_8—.001 μfd., 400 v. cond.
C_{10}—.005 μfd., 400 v. cond.
C_{13}—.25 μfd., 400 v. cond.
*Note: Values for C_2 and C_3 can be varied to change the variable boost frequencies. Increase C_2 for less low frequency boost. Increase C_3 for less high frequency boost.
V—6J7 tube
V—6SJ7 tube

Fig. 1. Complete circuit diagram. Tone controls provide a maximum of 10 db. boost.

level is changed. The first stage has a similar feedback loop without a volume control in its grid circuit. This feedback loop contains a variable network which allows the high and low frequency equalization to be changed by means of panel controls.

The extremes of equalization at the high and low frequencies are shown in the curve, Fig. 3. These variable controls allow the operator to set the response to his taste for different program material, speaker deficiencies, speaker location, and his particular ear peculiarities.

If the builder wishes to change the frequency at which the controls will boost the low frequencies, the .02 μfd. condenser (C_2) may be increased for a lower frequency boost and decreased to move the boost to a higher frequency. The high frequency boost can be likewise changed by increasing the value of the .02 μfd. condenser (C_3) for a lower high frequency boost and decreasing its value to move the boost to a higher frequency. After these variable controls are set, one can change the volume control setting and the reproduced sound will seem natural at all levels.

The unit was constructed on a "U"-shaped chassis, which affords good shielding for the various parts. It is wired point-to-point to keep the leads short. The heater wiring must be twisted and kept as far from the grid and plate pins of the tubes as possible.

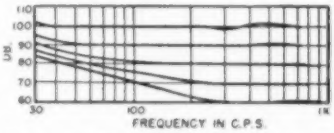


Fig. 2. Required equalization to compensate for deficiencies of the human ear at low frequencies with changes in output level.

A ground bus is used and is strongly recommended. *DO NOT* try to use a common wire in the power cable for 6.3v. and "B minus," or incurable hum will result. The heaters must have their center taps grounded rather than one side.

All grid leads should be shielded, as should the input and output cables. RG/8-U coaxial cable is a small, low capacity shielded cable intended for r.f. use. It is recommended for audio use because of its excellent insulation, low capacity, and small size.

The unit is readily mounted by means of the volume control nuts. It is connected to the main amplifier by cables containing the audio output of the unit and the power for the tubes. Most amplifiers will stand the additional drain of 6.3v. at 0.6 amp. and 200v. at 12 ma.

This remote location of the unit makes for convenience of mounting and removes the unit from troublesome hum fields. The input is suit-

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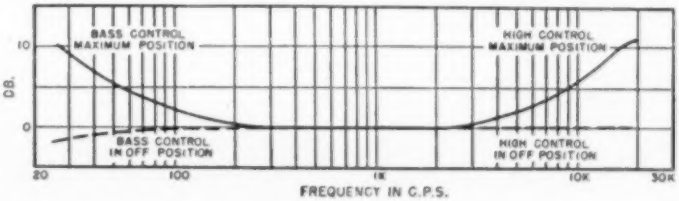
Fig. 3. Response curves show high and low boost range at various control settings.



The "AUDITIONER"

Closeup of "Hi-Fi Auditioner." Two dual-speed professional turntables and four pickups are used to demonstrate relative qualities of cartridges.

By
L. M. DEZETTEL
Allied Radio Corp.

Audio enthusiasts can select their custom equipment from the 371,293 possible combinations of amplifiers, pickups, tuners, etc. connected to the test console.

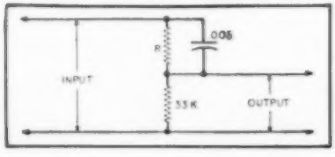
THERE has always been a scattered and unchartered group of hobbyists called "Hi-Fi Enthusiasts." These are people who wanted to hear good music at home, but couldn't get it from their "store bought'n" radio sets or record players. They felt, and rightly so, that each of the components of a system—the pickup and cartridge, the tuner, the amplifier, the speaker, the speaker enclosure—required individual design and proper construction to be good. Together these audio components could be combined into a system that would provide the wide frequency response and the low distortion required for proper reproduction of the original music. The hobbyists, at first, consisted of those technically qualified to build whichever components of a system could be built—the amplifier, the tuner, the speaker enclosure, and other cabinet work. But there are music lovers everywhere, and this small group of Hi-Fi enthusiasts was destined to grow. Increased demand for the components made it worthwhile for many manufacturers to come out with good units that the music lover, with even an average budget, could afford. The advent of a low priced variable reluctance cartridge probably gave this hobby its greatest impetus.

The number of manufacturers and the variety of models of amplifiers, tuners, etc., etc., grew in number until the choice of components was wide and varied. Soon the question of "what to buy?" became paramount. Radio parts and equipment distributors became the logical sales outlets for such components. They provided detailed catalogue descriptions based on manufacturers' literature and their own observations. An honest report of the technical specs made comparisons fairly easy. The high-fidelity fan usually based his selection of components on the data supplied by distributors' catalogues and literature, on information in radio and consumer publications, and by the limitations of his own pocketbook. Many buyers, however, began to ask for listening tests of various combinations. Sometimes they traveled for hundreds of miles to the nearest distributor in order to hear for themselves how a particular setup sounded.

Allied Radio was one of the first to feel the demand for a listening test. Our first equipment to facilitate comparisons consisted of a standard relay rack patch panel. Cords with dual plugs permitted us to "patch in" various components into a typical system. This procedure was slow and not fully flexible. We immediately began to design and custom-build a control console with push-button switching to provide a completely flexible system for instantaneously interconnecting any component with any other.

The "Hi-Fi Auditioner" installed in *Allied's* high fidelity sound studio consists of a specially-built metal sloping panel console cabinet. Rows of push-buttons on the sloping front panel operate multi-contact switches. Each row is assigned to one component type —one row for pickups, one for preamplifiers, one for tuners, etc. A center panel incorporates a system of lights behind translucent name plates. There is a light for every piece of equipment, identifying for the listener the units in the hookup. The switch buttons also carry the brandnames of the equipment. The table part of the console is a "sunken garden" arrangement of two professional turntables and four pickups, two for each turntable.

Equalizing network used to correct for the loss of high frequencies due to interlead capacitance. Value of resistor R is fixed for a given line length, 10,000 ohms for 15 feet or 22,000 ohms for 30 feet.



Before going into detail about the console, or "Auditioner" as we call it, let's consider the over-all demonstration setup. The console and equipment to be demonstrated are set up in a room especially designed to give a "living room" atmosphere and living room acoustics. A glass panelled door and a glass "picture window" are included to simulate the average amount of glass that might be found in the average home living room of the same size. A scattering of drapes over the picture window and other parts of the striated plywood panel walls, a carpeted floor, and a plain plastered ceiling give about the same reverberation time that would be encountered in the average home. A more ideal reverberation time could have been provided but average living rooms do not have ideal acoustical conditions. We did not want to mislead the listener with a demonstration that would not be duplicated when the equipment he purchased was operated in his own home.

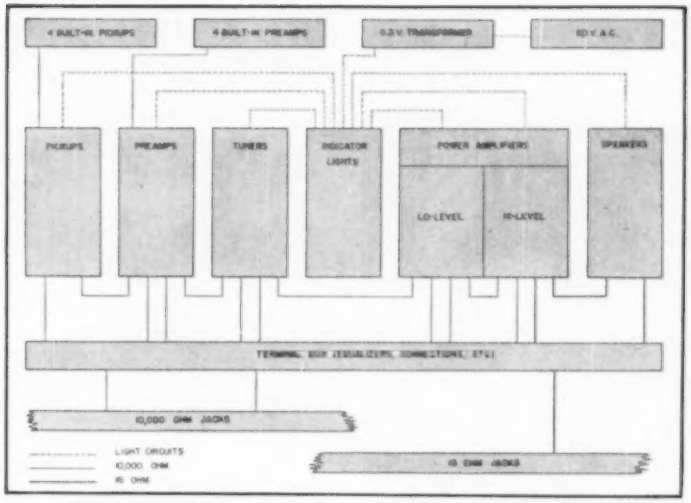
Shelves of amplifiers and some tun-

ers are installed near the console. Typical complete systems in cabinets, and a host of speakers in enclosures are located around the room. A comfortable divan, modern table, floor and table lamps are used to enhance the living room atmosphere.

A lot of effort, thought, and technical discussions preceded the final design of the "Hi-Fi Auditioner." The block diagram indicates the essential parts of the system. Three electrically and magnetically separated metal channels or ducts carry the connectors and cables from the components around the room to the console. They are grounded together at only one point in their entire lengths. The separation prevents hum pickup or oscillation by magnetic induction, and the single ground point eliminates "ground loops." One channel carries a.c. outlets. One channel carries all cables to the speakers, all at 16 ohms. The other channel carries all low level lines, at 10,000 ohms. We arbitrarily called these 10,000 ohm lines because the output of magnetic pickups, preamplifiers, and tuners (these outputs were from triode plates or cathode followers) were at about this impedance. There are 25 speaker sockets and 85 low-level (10,000 ohm) sockets, all of the two contact type, around the walls. All low-level cables are single-conductor, shielded. While the outer shields of the cables are also the ground returns, they are not tied together except at *one* point—at the console. Separate terminal boxes for the speaker leads and for the low-level leads are flush-mounted in the wall near the switching console. From these, cable bundles lead to the console through multi-contact AN plugs. Behind the AN sockets are 3-screw-per-cable terminals. These are used for the equalizing networks. These networks are designed to provide a high frequency rise to compensate for the loss of high frequencies because of cable capacity.

There are 6 rows of push-button switches, each row with 13 buttons. Each row handles a different type of component, except that two rows are used for amplifiers. There are 371,293 possible setup combinations with this system! The switch contacts are made of solid silver alloy for long life and low resistance. There are 24 contacts per button. A closed circuit affair is used, with each component "cut into" the line. The first row of switches selects the desired pickup, the output of which is fed to the second row of switches. The second row selects the preamplifier, cutting the pickup output into the input of the preamplifier, and feeding the output of the preamplifier on to the next row, which switches tuners. The bottom button of each row (except pickups and speakers) is a "through" button for feeding the signal onto the next row, without using a component from that row. Thus, a pickup signal may be fed straight through to a tuner or still farther down the line to an amplifier. Many amplifiers have high-gain, equal-

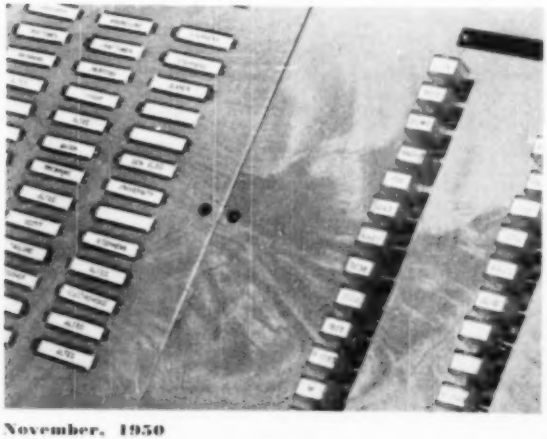
(*Continued on page* 112)



Block diagram showing the essential parts of the audio test console setup.

View of the rack which houses amplifiers and tuners used in the sound demonstrations. Because of the flexibility of the test setup new units can be substituted for older models.

Closeup view of the push-button controls. The buttons at the right select various components for demonstration. By merely pushing a button the desired equipment is brought into operation. Lights behind the name plates at the left indicate which unit is in use.



By
J. N. A. HAWKINS

Modern version of a 1938 design providing 96 db. and 10 watts.

Front panel view of the home-built, general purpose amplifier unit.

A Flexible General Purpose AMPLIFIER

THE trend in some manufactured amplifiers has been toward lowered costs at a noticeable sacrifice of performance and flexibility. It is getting rather difficult to find a high quality 10 watt amplifier with enough gain to allow good variable equalization, working from a source like a variable reluctance pickup. If low cost is a requirement the problem of finding a satisfactory amplifier package is multiplied. One answer to this problem is to build a Chinese copy of an outstandingly successful amplifier which has been thoroughly "exorcised."

The general purpose amplifier shown in the accompanying diagrams represents a series of progressive improvements over its original ancestor, which was an amplifier designed by George Downs in 1938 to test and demonstrate the early *Miller* lightweight pickup and the early *Lansing* two-way theater horn systems. Cary, Howard, Gilbert, Kelly, Hisserich, Bretell, and others have all contributed ideas to its development over the years and particular credit must be given to M. O. Kappler for the particular phase inverter used in the present version. Countless other commercial and amateur amplifiers have stemmed from the original Downs ancestor but many of them got lost because of trouble with the three-stage negative feedback. Those of us who have achieved success with this basic design agree that the only source of possible trouble is in the use of an unbalanced phase inverter and/or the use of a low grade output transformer. Many manufacturers of p.a. and b.c. studio equipment have built and sold various versions of this basic unit only to withdraw it from the market after six months or so. The explanation, in most cases, was that the early serial numbers worked fine but the later production runs were touchy and might oscillate, or sing, if the load was removed or tubes aged. In every case the cause could be traced to substitution of a lower priced output transformer or circuit simplification in the phase inverter, as compared with the original model. A lot of "ragged edge" feedback amplifiers will work pretty well as long as the load resistance is connected and as long as the tubes maintain their rated G_m. That is one of the beauties of feedback. However, it takes good design and a well built output transformer to operate well at non-standard line voltages, flat tubes, unbalanced tubes, and a highly reactive load like a speaker whose field has deteriorated.

One test of good phase-inverter and output transformer performance is to measure the maximum allowable feedback, before singing occurs, with a resistance termination on the output. In this amplifier singing occurs at about 30 db. of feedback (1000 cycles) terminated, with about 26 db. as the maximum for the unterminated condition. Ordinarily, good design suggests that the feedback be set at least 6 db. under the singing point terminated, which implies that no value of reactive load impedance can then cause singing. Actually, one can have too much feedback because only a very few measurement amplifiers need more stability than can be obtained with about 16 db. of feedback. With the constants shown, this amplifier has 17.6 db. of feedback, when working into a resistance termination. Working into an average 16 ohm speaker voice coil the feedback differed from the resistance termination figure by only a few tenths of a db. The feedback could be increased to 24 db. if desired, but no measurable improvement in frequency response nor intermodulation distortion resulted so there was no point in throwing away the 6 db. of net gain involved just to be able to say that the unit had 24 db. of feedback.

Circuit Details

The amplifier has two input circuits so that sound sources of about 30 db. difference in 1000 cycle output can be handled without having to locate a gain control in a low level grid circuit. Actually, the high gain input was designed and equalized for a variable reluctance pickup, with the lower gain input designed for a crystal pickup. This feature is growing in popularity as critical record enthusiasts are indicating a preference for the variable reluctance pickup for 78 and 33 r.p.m. discs, with a good crystal the choice for the 45 r.p.m. discs. This fits in rather nicely with the belief that while there are several good combination 78 and 33 r.p.m. record changing mechanisms plus several good single speed 45 r.p.m. changers there does not

seem to be a good three speed changer mechanism available that is completely happy at all three speeds and under all conditions of disc loading. Thus the high gain input gives a net corrected gain of 96 db. to the output terminals, while the low gain input shows a net gain of 70 db. Some thought was given to a d.c. filament supply but it will be found that turntable rumble will usually be more bothersome than the heater hum with the 60 db. volume range obtainable from this amplifier.

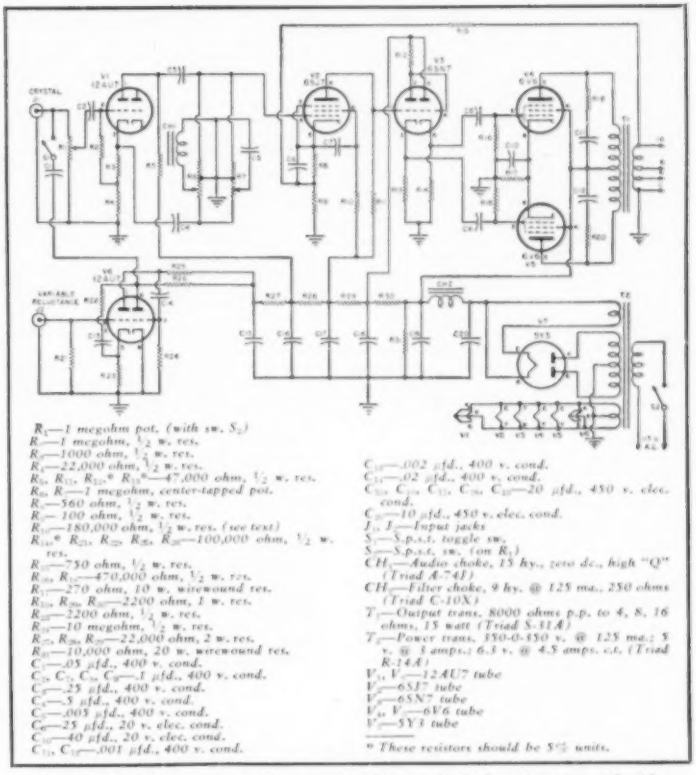
The preamplifier circuit is rather conventional except for the two-stage feedback whose purpose is fixed equalization and noise reduction. The feedback also acts to reduce the source impedance of the plate circuit of the second preamp stage and to keep it constant and independent of the tube aging, which would adversely affect the stability of the variable equalizer which follows the two-stage preamplifier. This particular equalizer is simple and effective. It allows separate adjustment of the low and high ends with 600 cycles kept constant. The 60 cycles can be raised 12 and cut 22 db., while 6000 cycles can be raised 12 db. and cut 18 db.

Any discussion of the theory of equalization will automatically produce a storm of mail for any technical writer so this one will merely say that after 20 odd years of building them, bearing with them, and burying them, I like the axis to bend up and down at 600 cycles, the geometric mean of the high fidelity speech band. I also like 60 and 6000 cycles as the design points for a combination equalizer and band limiting filter for music played at normal home volume. So you don't agree with me?—OK, so keep the iron hot and the *CR* box handy but the circuit and equalizer coil is a very good deal for a starter. This equalizer circuit has low insertion loss, being a feedback equalizer on the second preamp plate-cathode circuit, and has negligible transient and amplitude distortion. The A-74J has 70 db. of shielding, a very important item where the coil is followed by this much gain.

At the volume control the amplifier divides into what amounts to two parts. The first half is the three-stage preamp and equalizer followed by a high quality bridging amplifier with three-stage feedback giving exceptionally low noise and distortion. An extra input at the bridging amplifier input might be handy for program material that does not require variable equalization. (Is there any such program material?)

The first stage of the bridging amplifier is a rather conventional 6SJ7 stage with two points of interest. Note that the feedback from the voice coil winding (properly phased) is applied to the cathode tap and further note that there is no blocking condenser between the 6SJ7 plate and the first grid of the 6SN7 phase inverter. This d.c. coupling is very important in reducing the low frequency phase shift of the amplifier, which allows maximum feedback without low frequency motorboating. (High frequency phase shift is neutralized by the *RC* network across the primary of the output transformer.)

There is one semi-critical adjustment in the 6SJ7 stage and it is the only balance adjustment in the whole amplifier. The 180,000 ohm screen dropping resistor has to be trimmed to adjust the bias on the phase inverter. The bias on both halves of the 6SN7 is adjusted by means of the screen voltage of the 6SJ7. This adjustment does not have too much effect on the balance of the 6SN7 Kappler phase inverter but it sets the overload point and source resistance



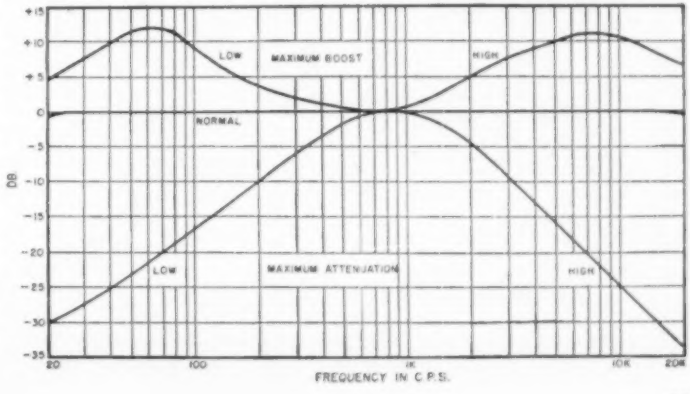
R_1—1 megohm pot. (with sw. S_2)
R_2—1 megohm, ½ w. res.
R_3—1000 ohm, ½ w. res.
R_4—22,000 ohm, ½ w. res.
R_5, R_{13}, R_{32},* R_{33}*—47,000 ohm, ½ w. res.
R_6, R_{12}—1 megohm, center-tapped pot.
R_7—560 ohm, ½ w. res.
R_8—100 ohm, ½ w. res.
R_{10}—180,000 ohm, ½ w. res. (see text)
R_{11},* R_{23}, R_{25}, R_{26}—100,000 ohm, ½ w. res.
R_{15}—750 ohm, ½ w. res.
R_{16}, R_{17}—470,000 ohm, ½ w. res.
R_{17}—270 ohm, 10 w. wirewound res.
R_{18}, R_{20}, R_{21}—2200 ohm, 1 w. res.
R_{22}—3200 ohm, ½ w. res.
R_{24}—10 megohm, ½ w. res.
R_{27}, R_{28}, R_{29}—22,000 ohm, 2 w. res.
R_{31}—10,000 ohm, 20 w. wirewound res.
C_1—.05 μfd., 400 v. cond.
C_2, C_3, C_4, C_9—.1 μfd., 400 v. cond.
C_5—.25 μfd., 400 v. cond.
C_6—.5 μfd., 400 v. cond.
C_7—.005 μfd., 400 v. cond.
C_{10}—25 μfd., 20 v. elec. cond.
C_{11}—40 μfd., 20 v. elec. cond.
C_{12}, C_{13}—.001 μfd., 400 v. cond.
C_{14}—.002 μfd., 400 v. cond.
C_{15}—.02 μfd., 400 v. cond.
C_{16}, C_{17}, C_{18}, C_{19}—20 μfd., 450 v. elec. cond.
C_{20}—10 μfd., 450 v. elec. cond.
J_1, J_2—Input jacks
S_1—S.p.s.t. toggle sw.
S_2—S.p.s.t. sw. (on R_1)
CH_1—Audio choke, 15 hy., zero d.c., high "Q" (Triad A-74J)
CH_2—Filter choke, 9 hy. @ 125 ma., 250 ohms (Triad C-10X)
T_1—Output trans. 8000 ohms p.p. to 4, 8, 16 ohms, 15 watt (Triad S-81A)
T_2—Power trans. 350-0-350 v. @ 125 ma.; 5 v. @ 3 amps.; 6.3 v. @ 4.5 amps. c.t. (Triad R-14A)
V_1, $V_{...}$—12AU7 tube
V_2—6SJ7 tube
V_3—6SN7 tube
V_4, $V_{...}$—6V6 tube
V_7—5Y3 tube

* These resistors should be 5% units.

Three feedback loops, d.c. coupling to and within a radical phase inverter, and wide-range variable equalization are featured in this new general-purpose amplifier design.

amplifier. The 180,000 ohm screen dropping resistor has to be trimmed to adjust the bias on the phase inverter. The bias on both halves of the 6SN7 is adjusted by means of the screen voltage of the 6SJ7. This adjustment does not have too much effect on the balance of the 6SN7 Kappler phase inverter but it sets the overload point and source resistance

Equalization curves showing available boost and cut in the new feedback equalizer which is characterized by wide range and low insertion loss.



of the two halves of the 6SN7 output circuit for the most graceful overload curve. This results in low, even-order harmonics even well into overload. This amplifier can be operated 3 to 5 db. higher than amplifiers of similar power rating because of the graceful way it slides into overload, thus taking the curse off the occasional high level peaks that sneak through.

The Kappler phase inverter is interesting because of its direct coupled input and interstage circuits. The elimination of coupling condensers is extremely important in stable feedback amplifiers. In fact, it is coupling reactances, such as blocking condensers and transformers, which limit feedback and not the number of vacuum tube stages within the feedback loop. In this three-stage bridging amplifier the two blocking condensers between the cathodes of the 6SN7 phase inverter and the grids of the 6V6 power amplifier are substantially in parallel as far as their contribution to phase shift and singing are concerned. Thus, this bridging section might be thought to include one blocking condenser and one transformer in the feedback loop, a feature which provides great stability against motorboating and high frequency oscillation.

By driving the 6V6 grids from low impedance cathodes of the preceding phase inverter stage the exciting voltage comes from a source of good voltage regulation so that the output grids can go slightly positive on level peaks without excessive peak clipping and consequent high order distortion.

The output circuit is conventional except that a phase correcting network is tied across the primary of the *Triad* S-31A output transformer. If any other output transformer is substituted a different phase shift network will be necessary. Many builders may infer that such phase shift networks are undesirable and may point out that their particular amplifiers need no phase correcting networks. My question to them would be, "Does *your* amplifier put 30 db. of feedback around three stages without oscillation?" This S-31A seems to have much better than average balance and lower leakage reactance than many output transformers selling for several times the price. The phase shift network might be eliminated by using the *Triad* HS-81 which has less high frequency phase shift, due to materially lower leakage reactance, and the extra octave of response is attractive to those with big horn systems.

The primary winding of the output transformer should be reversed if the amplifier sings, as one polarity of feedback is positive while the proper polarity acts to reduce the gross gain of the amplifier.

The screen voltage of the 6SJ7 stage should be set with a cathode-ray scope measuring the tone amplitude on each 6V6 grid in succession. The proper screen voltage setting is that which produces equal voltage just below the 6V6 grid current point.

The three phase inverter resistors of 47,000, 47,000, and 100,000 should be within 5% of the specified value. All the others can be the usual 10% to 20% tolerance. The plate supply voltage to the 6V6's is 275 volts and they operate as a relaxed class A, which is the most economical compromise for production tubes.

Conclusion

Under most home listening conditions the average audio power used is somewhere between one hundred and five hundred milliwatts.

On selections of great dynamic range, however, the peak passages may require several watts power. If the initial level is high, these peaks may well cause objectionable distortion due to overloading of the amplifier.

Many otherwise excellent amplifiers have a sharp rise in the distortion percentage when the rated output of the amplifier is exceeded.

As this amplifier has a very gradual increase in distortion, even above its rated output, it is capable of handling peak passages requiring great power without the distortion level becoming objectionable.

An often overlooked source of distortion is that caused by inferior speakers or speakers that are operated beyond their linear operating point.

Many of the low cost speakers will give excellent performance at low levels, but when their rated output is approached, the distortion becomes objectionable. Too often, this distortion is charged to the amplifier.

It would probably be well, before condemning an amplifier for poor performance, to make some further checks using speakers of known high quality. In this manner the defect may be easily localized.

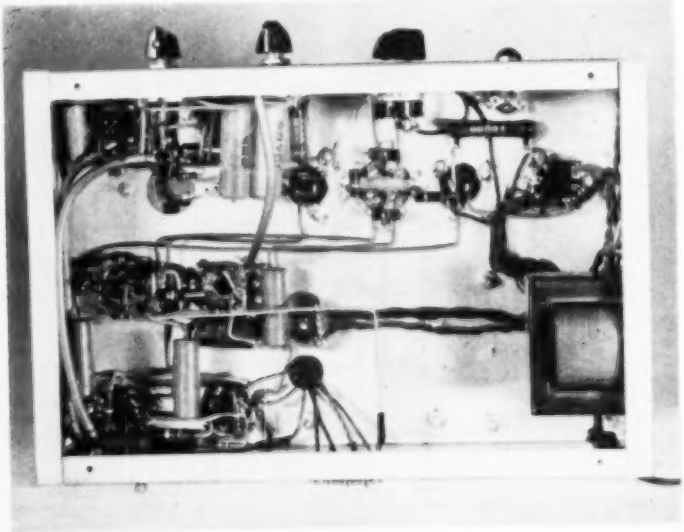
This amplifier was designed to give about 10 watts without strain. The 0.3% amplitude distortion point is about 3 watts from 35 to 15,000 cycles. At 1% distortion the power output is 10 watts, from 35 to 15,000 cycles. At 5% distortion the power output is about 15 watts.

Much thought was given to the 6L6G *vs.* the 6V6GT for the output stage. The 6V6GT is made in vastly larger quantities than the 6L6G. It seems to suffer less from the annoying habit of periodically depositing active cathode material on the control grid, with consequent primary emission from the hot control grid which produces a very bothersome high order distortion.

Also it was felt that very few home horn systems are so inefficient that a good ten watt amplifier won't provide a good 10 db. of volume leeway in order to show the neighbors what you can do if you try. Actually, many music friends like to insert a 2 to 4 db. pad between the amplifier and the horn system so that the amplifier can pretend it is working into a gain set, and also so that the horn system can pretend it is being fed from Boulder Dam. A 2 db. pad in the output of this amplifier will have no noticeable effect on volume but may smooth out a dividing network so that it begins to operate as its designer hoped it might. This pad will also improve the volume range if you need another excuse to help justify its use.

When you have this amplifier working you can know that it is not a one man job dreamed up in a week to fit a particular chassis but represents 12 years of continuing development by top sound engineers working in a dozen different laboratories. —30—

Under chassis view of the general-purpose amplifier showing the simplicity of wiring.



CONTROLLING HUM IN AUDIO AMPLIFIERS

By
LAWRENCE FLEMING

How to recognize characteristic types of hum and simple methods for attenuating this interference.

THE reduction of hum is a problem that sooner or later confronts every designer or builder of a.c. powered audio equipment. When there is plenty of room on the chassis and the input signal level is fairly high, say 1 volt, the job may amount to no more than relocating a grid lead or remembering to ground the heater supply. High-gain equipment however, working from a microphone or other low-level input, can present some tricky problems.

The purpose of this article is to describe the different ways in which hum can enter audio systems, to give some guide to the recognition of characteristic types of hum from different sources, and to cover practical methods of getting rid of the stuff. Shielding, chassis layout, planning of ground leads, choice of tubes, and filtering all enter into the problem. No instruments are needed to do a good job, although an oscilloscope is very helpful and a high-sensitivity a.c. vacuum tube voltmeter quite useful.

High-fidelity reproduction of sound demands a much lower relative hum level than does ordinary radio quality. In a good audio system the hum (as well as other noise) should be 50 or 60 db. below average listening level. Out of a 5-inch speaker a 30 db. ratio is tolerable. Public address amplifiers are often rated in hum level below full output. In a high-quality home installation this type of rating is misleading, because a good 20-watt amplifier in a living room is usually operated at 1 or 2 watts output, while the p.a. system is run closer to full blast.

The low signal levels available from tape playback heads and variable-reluctance phonograph pickups, together with the bass equalization required, aggravate the situation. Two other factors tend to alleviate it somewhat; the comparatively small dynamic range of records and tape—30 to 50 db., and the low impedance of such pickups at 60 cycles. With these new low-level input sources in wide use, however, good quality reproduction requires more careful attention to the reduction of hum than ever before.

Plate supply ripple due to insufficient filtering is always a pure 120-cycle note, and can be readily located by clipping extra condensers across the "B" supply. The actual design of power supply filters is a process of calculating the minimum size of chokes and condensers to insure a certain hum level, and it would not be appropriate to go into it here. Modern electrolytic condensers are cheap and of excellent quality, being used in some of the finest laboratory equipment. A single pi-section of filter, using a good choke, is generally adequate for any power stage, and an additional RC section for each preceding voltage amplifier stage will insure freedom from ripple as well as providing plenty of decoupling. There should be some series impedance in the positive side of the filter system, not all in the negative side, to get rid of ripple coupled through the power transformer capacitance. It is important to remember that filtering action is better for a given section, the lower the d.c. current drain, so that an RC filter section supplying only a milliampere or two to a resistance-coupled stage will give you much more filtering for your money than a similar section feeding a stage that draws a lot of current.

Many excellent commercial amplifiers use no filter chokes at all, and many fewer sections than suggested above. One can usually get satisfactory results with this type of design, but the proper procedure is to start out with plenty of filter, and then start cutting down and rearranging.

Push-pull stages require less filtering and decoupling than single-ended stages. Power pentodes are more tolerant of plate (not screen) supply ripple than are triodes, because of their high plate resistance, i.e., a volt of ripple produces less plate current swing. Negative feedback over the output stage will attenuate hum originating in that stage, but will not reduce hum originating at the input end of the feedback loop.

Plate Impedance Effect

The ripple voltage actually appearing at the plate of a tube is less than that at the "B —" terminal by the ratio: $R_L/(R_L + R_p)$ where R_L is the plate load resistance, and R_p the plate resistance of the tube. In Fig. 1, if the tube is a 6J5 operating with a

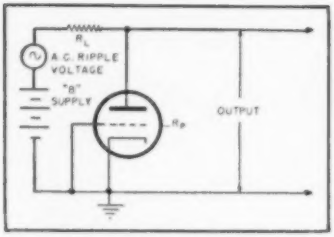


Fig. 1. Voltage divider effect attenuating plate supply ripple. The tube output is less than the "B" supply ripple by approximately the ratio of plate load resistance to plate impedance of the tube.

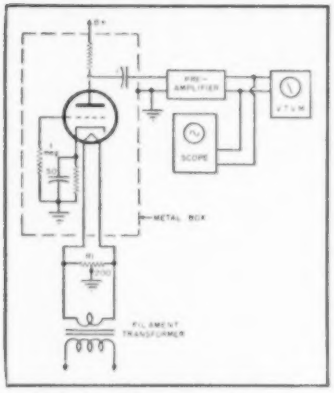


Fig. 2. Setup for measuring tube hum.

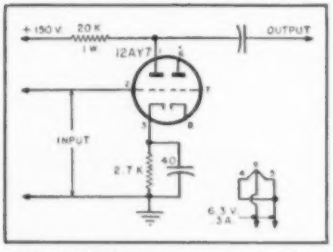
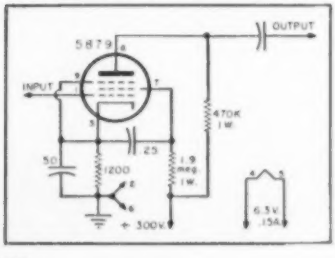


Fig. 3. Manufacturer's recommended circuit for 12AY7 as a low-level amplifier. Only one of the triode sections is shown.

★

Fig. 4. Recommended circuit for new RCA 5879 as a low level audio amplifier. Pins 2 and 6 should be grounded. Gain is 150.



100,000 ohm load R_L and a plate impedance R_p of 10,000 ohms, only $\frac{1}{11}$ of the "B" supply ripple will appear at the plate. An attenuation of at most 2 or 3 to one can be obtained with high-mu triodes, and practically none with pentodes.

Grounding and Balancing

In wide-range, low-level equipment with a.c. heater supply to the input stage it is advisable to use a hum-balancing potentiometer of 200 ohms or so across the heater supply, with the arm grounded. This adjustment will usually reduce the hum level of the input stage 10 db. over the level obtained when using a fixed center-tap. The total reduction over an arrangement with one side of the 6.3-volt supply grounded is from 20 to 30 db. The optimum adjustment varies slightly from tube to tube, and is less critical the lower the impedance in the grid circuit.

Everyone knows that heater supplies should be tied to ground or to a point having some definite d.c. potential (and bypassed to ground with 0.1 μfd. or so) but the reason why may not be obvious. A floating heater supply winding assumes a high a.c. potential, which it obtains through its capacitance to the high-voltage winding of the power transformer. Through capacitance and leakage from heater to grid, and other paths, this high a.c. potential couples large hum voltages into the signal circuits. It can even break down the heater-cathode insulation inside tubes.

When one side of the heater supply is grounded, the a.c. potential available for such stray coupling into the signal circuits is only 6 volts instead of perhaps 300.

When the center-tap is grounded, two a.c. potentials of 3 volts each are on hand, to couple hum into the grid circuit, but are 180 degrees out of phase. Their effects approximately cancel. If the stray impedances from each side of the heater to the grid are exactly equal, an exact center-tap will neutralize the hum. Since they are not exactly the same an adjustment is necessary.

Choice of Tubes

Table 1 lists tubes recommended by the manufacturers for low hum, noise, and microphonic applications. Table 2 gives hum data on some standard receiving types as measured by the author.

For commercial service it is better to use one of the special types listed in Table 1, since the hum characteristics of ordinary types often depend on variables that are not controlled in production, and the special types are better and more consistent microphonically. Type 1620 was omitted from Table 1 because it is seldom seen nowadays. It is a selected 6J7.

Nevertheless, a selected 6AU6, with a hum balance adjustment, can be so quiet that nothing but thermal noise can be seen on an oscilloscope, i.e., an equivalent hum input at the grid of less than 10 microvolts, when using a 1 megohm grid resistor.

The data in Table 2 is based on measurements made on four tubes of at least two different makes of each type. The test circuit is shown in Fig. 2. Plate resistors were 470,000 ohms for pentode types and 100,000 ohms for triodes. Cathode and screen resistors followed tube manual recommendations. The 6AU6 was best, the 12AT7 next, and a close third was type 6J7, the old standby of the broadcast industry for preamplifier service. 6C4's were spotty and generally poor. All these types require selection for good results. One-half to a third of a random collection of tubes might turn out good. The 6J7 may have the edge on microphonics; some 6AU6's are loose inside and noisy, but a good one is excellent. 12AT7's showed more variation than 6AU6's. The latter, incidentally, with screen and suppressor tied to the plate makes a good triode with a mu of 40.

Investigation of larger samples of these and other modern miniature types should be very fruitful, and it is hoped that someone with the time and facilities will undertake it.

Figs. 3 and 4 show typical circuits recommended by the manufacturers for the 12AY7 and the 5879. An exception is that screen and cathode bypasses are shown larger for the 5879 than the data sheet recommends, because it is felt that cutting down the bass response is not the best way to reduce hum.

Fig. 5 shows a complete low-level input stage using a 6AU6, on which was measured a hum output equivalent to less than 10 microvolts at the grid. The "B" supply was a conventional transformer and rectifier system with one pi-section of filter, but the only current drain was that of the stage shown.

Inside Tubes

Several things inside a tube contribute to a.c. ripple in its output. Consideration of these factors leads naturally to circuit planning for hum reduction, too; and these will be taken up presently. The first source of hum in the tube is leakage current between the heater and the cathode. This current is said to be around 0.04 microampere for voltage amplifier types and 1 microampere for power tubes. No definite data is available, but this leakage current probably increases greatly over these values as the tube ages. It is known to increase with heater voltage. Low-level audio stages should never have over 6.3 volts applied to the heater, and preferably about 5.8 volts. In the circuit of Fig. 5, increasing the supply from 5.8 volts to 6.6 volts doubled the hum output.

The effect of this leakage current is eliminated by keeping the d.c. potential low between heater and cathode (not over 10 or 20 volts) and by using a cathode bypass capacitance of not less than 40 μfd.

Electrolytic condensers are perfect-

ly quiet. Grid bias cells however are apt to be noisy at millivolt levels.

It is very difficult to get the hum low in a cathode follower.

Heater-Grid Leakage

Resistive leakage from heater to grid can be troublesome. If, for example there is 10,000 megohms of unbalanced leakage from a 6 volt source to the grid, and the input circuit impedance is 1 megohm, 0.6 millivolt of 60 cycle a.c. will appear at the grid. Leakage of this magnitude is not unusual across black phenolic tube bases and sockets, not to mention cotton insulation on pushback wire. With single-ended tubes, mica-filled or ceramic sockets are advisable.

Heater-Grid Capacitance

The capacitance between the heater leads and the grid is an important hum characteristic of a tube type. The low-noise types in Table 1 have internal shielding between the grid and heater. 1 $\mu\mu$fd. of stray unbalanced capacitance here will introduce 2 millivolts of hum into a 1 megohm grid circuit. The situation is saved in practice by hum balancing and by the fact that the actual capacitance inside miniature tubes is less than 1 $\mu\mu$fd., and that the impedance presented to the grid circuit by phonograph pickups, tape heads, and microphones is a good deal less than a megohm, provided, that is, that the layout minimizes the stray capacitance which unavoidably remains.

Capacitive Hum Balancing

A fine adjustment on heater supply center-tapping can be obtained by trimming the capacitances between either side of the heater and the grid, as well as by using a potentiometer. Adequate trimming can usually be effected by lead dress alone. Bring an inch or less of heater lead close to the grid lead, using an insulating rod for a tool. One side of the a.c. supply will increase the hum level, the other side will reduce it. Observation of the tube output on an oscilloscope or meter is rather necessary during this operation.

Wiring Techniques

Most of the considerations outlined above as relating to hum in tubes apply as well to the wiring that goes to the tubes. Capacitance from any a.c. wiring to a low-level signal circuit introduces a 60 cycle voltage therein in direct proportion to the a.c. voltage present, the stray capacitance, and the impedance of the affected circuit. In Fig. 6A, suppose we have a grid circuit with a resistance R of 1 megohm, having its high side coupled to a source of a.c. E_H through a stray capacitance C_H. If the hum voltage E_H is 1 volt, there will appear at the grid 1/2300 of a volt, or about half a millivolt, since the reactance of 1 $\mu\mu$fd. at 60 cycles is about 2300 megohms. This is only 26 db. below 10 millivolts. If C_H should be coupled to a 300-volt power transformer lead, the grid circuit would receive 300/2300 volt, or 0.15 volt—an intolerable level. 1 $\mu\mu$fd. is about what you get between two pieces of pushback wire an inch long twisted loosely together.

TYPE	HEATER	DESCRIPTION
12AY7	6.3 12.6 v.; .3 .15 amp.	Double triode, noval miniature, mu = 35
5879 (RCA)	6.3 v.; .15 amp.	Voltage amplifier pentode, noval miniature
347A (Western Electric)	6.3 v.; .6 amp.	Triode, glass octal with top cap, mu = 16

Table 1. Tubes recommended for low-hum, low-microphonic applications.

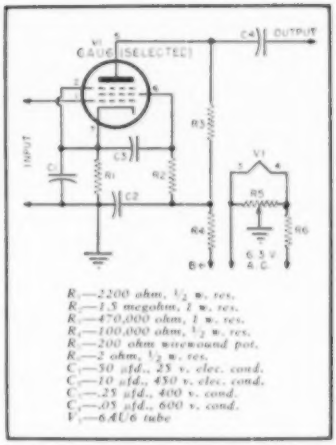
Fig. 6B illustrates the same situation when the signal source C is capacitive, as crystal microphones and pickups. The stray "hum" capacitance and the signal source act simply as a capacitive voltage divider. If C is 2000 $\mu\mu$fd. and E_H 1 volt, the a.c. voltage at the grid will be 1/2000 volt.

All this does not mean that one should shield the daylights out of all low-level wiring, and locate input stages a yard away from everything else. Rather, it is necessary to be aware of the magnitudes of these effects, and to recognize a defective wiring layout. Lavish use of tinned copper braid is rarely necessary. It is really needed only to salvage a poorly-planned chassis layout, or in unusually compact assemblies, or when gain and tone controls are grouped together at some point removed from the associated circuits. The capacitance between two wires can be very close to zero if (1) they are a couple of inches apart, (2) they are kept close to the chassis, not up in the air; and (3) advantage is taken of natural cover to help in shielding, i.e., bypass condensers, d.c. wiring, and other "cold" components.

Twisting of heater leads, incidentally, is not too necessary if they are close together and grid leads are kept away. With top-cap tubes it is well to use braid on the grid lead and to put a "hat" shield over the grid cap.

Magnetization of Tubes

Glass tubes of a given type show more individual variation in hum level than metal tubes. The British journal *Wireless World* has reported the discovery that this phenomenon is associated with permanent magnetization of the tube elements, which seems to increase the hum level in a way not



R_1—2200 ohm, ½ w. res.
R_2—1.5 megohm, 1 w. res.
R_3—470,000 ohm, 1 w. res.
R_4—100,000 ohm, ½ w. res.
R_5—200 ohm wirewound pot.
R_6—2 ohm, ½ w. res.
C_1—50 μfd., 25 v. elec. cond.
C_2—10 μfd., 450 v. elec. cond.
C_3—.25 μfd., 400 v. cond.
C_4—.05 μfd., 600 v. cond.
V_1—6AU6 tube

Fig. 5. Low-noise preamp using 6AU6.

TYPE	HUM LEVEL (Referred to Grid)	REMARKS
6AU6	5-10 μv.	Fairly uniform
12AT7	10-30 μv.	Not very uniform, some tubes noisy and microphonic
6J7	30-50 μv.	Fairly uniform and quiet
6C4	10-100 μv.	Wide variation, some tubes very noisy

Table 2. The measured attainable hum levels of standard receiving tubes.

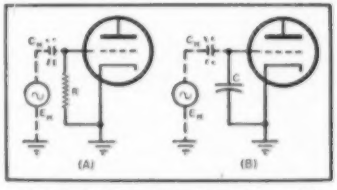


Fig. 6. (A) Capacitive hum pickup. (B) Capacitive hum pickup in crystal microphone or in phonograph input circuits.

Table 3. Some of the most common sources of hum and a listing of possible remedies.

SOURCE	REMEDY
1. "B" supply ripple	Filtering; use larger screen bypass in pentodes; use high load resistance with triodes.
2. Capacitive pickup from a.c. wiring to tube grids	Separation of leads; shielding; use potentiometer for grounding center of heater supply.
3. Heater-grid leakage	Mica-filled or ceramic sockets; keep wiring separated.
4. Heater-cathode leakage	Use cathode bypass of at least 40 μfd. Try positive d.c. bias of about 5 v. on heater supply.
5. Magnetic a.c. modulation of tube plate current	Locate input tube 6" or more from power transformer and phono motor. Use iron shield on glass tubes.
6. Chassis gradients	Ground grid return and cathode return to same point.
7. Gradients along cable shields	Ground mike or phono pickup shield at one point only; use separate lead to interconnect chassis; keep both leads close together.
8. Ground loops	Keep grid and return leads close together and away from power transformer. Interconnect ground tie points through only one path. Do not duplicate separate chassis grounds with wire interconnections.

yet understood. The remedy is demagnetization with a gradually-removed 60 cycle field, the same as jewelers do with watches. The winding of an old power transformer, removed from the core, can be used for a demagnetizing coil. Connect the secondary across the 115 volt line (using series resistance if necessary, to keep it from getting too hot), insert the tube, then slowly withdraw it.

Chassis Currents

Gradients of the order of half a millivolt per foot often exist across a chassis on which a power transformer is mounted. The transformer winding induces a 60 cycle voltage, causing a circulating current in the chassis. Hence it is not good to include a hunk of chassis in series with a low-level input circuit. Fig. 7C illustrates what happens when the cathode and grid of a tube are returned to different points. E_H denotes a hum voltage distributed along the chassis. This voltage is included right in with the signal. The remedy is to return grid and cathode to the same point, as in Fig. 7F.

Ground Loops

When one starts wiring from a diagram without thinking too much about the purpose of each lead, the situation indicated in Fig. 7B may develop. Here, too many ground leads have been used, forming a shorted turn or ground loop. Stray magnetic fields eagerly induce a.c. voltage in such a loop, and the voltage across a portion of the loop is included in the grid circuit. The effect is usually very small, but an aggravated case can cause trouble.

If the grid lead and grid return be too widely separated, as indicated in Fig 7E, another one-turn coil is created, ripe for the induction of 60 cycle voltage. Since the voltage induced in a loop is proportional to its area, the remedy is to keep the grid lead and return lead close together.

These magnetic effects are aggravated when they are on the low-impedance side of an input transformer. Phonograph motors have magnetic fields just like power transformers.

Magnetic Pickups

Fig. 7A shows a situation often encountered when using pickups of low output level, such as the *GE* and *Pickering*. Here the shielded pickup cable is grounded to the motor frame at one end, and to the amplifier chassis at the other. The motor frame has a fair-sized capacitance to the 110 volt line, as does the amplifier chassis. These capacitances are indicated as C_1 and C_2 in the diagram, with the line voltage in between. C_1 and C_2 can be as large as 0.1 μfd. if line isolating condensers are used. A hum voltage is thus applied across the ends of the cable shield, and the resulting voltage drop can be as much as 50 microvolts, included directly in the grid circuit. The remedy is to use the shield only for the signal voltage, and to employ a separate wire to connect the two chassis, as shown in Fig. 7D. This wire should be close to the cable to avoid loop pickup effects which can be just as bad. Two-conductor shield cable can be used, too.

Tape Recorders

Tape playback is the most critical problem of all, because of the very low output level of tape heads—1 millivolt or so—and the heavy bass equalization required. All the precautions must be observed. An important residual hum source is a.c. magnetic induction in the playback head itself. *Audio Engineering* has reported a simple method of neutralizing the residual induced hum. Attach a small piece of sheet iron, ½ inch square or so, to a stick, and try holding it in various positions near the playback head until a location is found that dips the hum level to a minimum. Then permanently fix the iron piece in place. *Permalloy* is better.

The iron acts as a distorter of the field, and, in the right position equalizes the effective fields applied to the two sections of the hum-bucking winding used in the head.

Audio Transformers

Unshielded low-level input transformers pick up hum from power transformer and motor fields, typically on the order of a few millivolts across the high winding. At microphone levels, an ordinary strap-mounted or similar input transformer simply cannot be used on the same chassis with a power transformer. This is why intercom sets always use an a.c.-d.c. type circuit.

Transformers of the two-coil "humbucking" construction are somewhat better. If adjustably mounted at least a foot from the power transformer, such a unit can be oriented to be quiet enough for p.a. purposes, but not for broadcast quality. The small "ouncer" size is about as good, since hum pickup decreases with size.

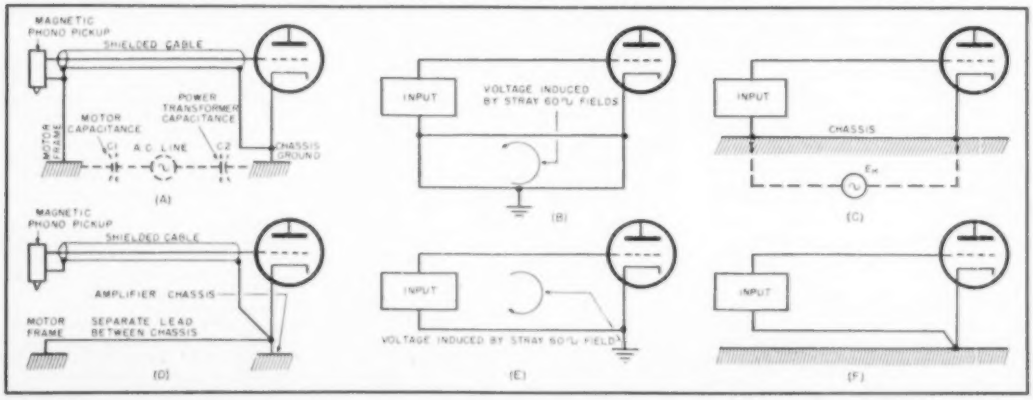
By far the best construction is that with multiple telescopic *Permalloy* shields. A cast iron case alone does little good. Multiple alloy shielded units are at least 30 db. better than any other construction. The writer disassembled a transformer of this type once and found that each shield can reduce the induced hum 20 db., a total of 60 db. for the three cans.

Hum Characteristics

Fig. 8 shows tracings taken from an oscilloscope screen, with typical waveforms of a.c. pickup from various sources. They have certain distinctive qualities. Straight capacitive pickup is a slightly rough 60-cycle wave. Plate supply ripple due to insufficient filtering is a very smooth

(*Continued on page* 180)

Fig. 7. (A) Hum induction by using cable shield to interconnect phonograph turntable and amplifier chassis. (B) A ground loop. One of the three ground leads should be opened. (C) Hum injected into input circuit from a.c. voltage gradient along chassis. (D) Correct method of connecting low-level phonograph pickup to amplifier. (E) An input wiring loop. This can give trouble in tape playback input circuits if loop is close to motor or power transformer. Shielding grid lead alone will not help. Loop must be closed up by making shield the only path between low side of signal source and cathode return of first tube. (F) Grounding grid return and cathode to same point to avoid hum from chassis gradients.



A High-Quality SOUND SYSTEM for the Home

By
H. F. OLSON
&
A. R. MORGAN
RCA Laboratories

Fig. 1. Complete sound system including a 9JY record changer, amplifier, and the RCA type LC1A loudspeaker and cabinet assembly.

Analysis of the problems encountered by the audio enthusiast in designing and building his own relatively low-cost, high-quality audio system.

THE main objective of this article is a rationalization of the problems confronting the enthusiast for good sound reproduction.

The statement, "high quality sound reproduction," implies a desire for realism or naturalness in the reproduced sound. The ideal in sound reproduction would result from subjecting each of the listener's ears to the exact sound that would be received by attending the original source. To achieve this ideal, resort must be made to such complications as Binaural[1] or Auditory Perspective[2,3,4] Reproducing Systems. These systems are not within the province of practicality and need be discussed no further.

Practical considerations dictate the use of monaural or single channel reproducing systems. The ideal of this system would be an exact reproduction, from the loudspeaker, of the sound impressed on the microphone of the system. To the enthusiast, then, the basic problem involves the cost of a satisfactory approach to this ideal. He finds that he must weigh such factors as response, distortion, and power output against cost.

A reasonable solution for the problem will result from limiting the demands on the system to those which are truly needed for satisfactory high-quality sound reproduction in the home. If this approach is used, it is possible to develop a wide range, low distortion sound reproducing system in which the cost is comparable to the cost of mass produced systems.

It is a further objective of this article to describe in detail the elements and performance characteristics of a practical high-quality sound reproducing system consisting of a record player, amplifier, loudspeaker unit, and cabinet. This description will enable the enthusiast to assemble a high-quality sound reproducing system at a moderate cost.

Frequency Response

To determine the frequency response needed for an ideal sound reproducing system, it is necessary to consider, in combination, the response of the human ear and the frequency ranges encountered in speech and music. The frequency range of the average normal ear[5] is from 20 to 20,000 cycles. It is likely that frequencies higher and lower than the limits of the ear will, at times, be encountered in music or in certain noises. It has been shown[6,7] however, that the frequency range required for no appreciable loss in quality of reproduction is from 40 to 15,000 cycles. This range, therefore, might well be treated as an ideal.

Any attempt to evaluate the effect of restricting the frequency range of reproduction involves a personal judgment of quality and for all but minor range restrictions can be very confusing. Since the purpose of this discussion is to establish a criterion for high-quality reproduction, the drastic frequency range restrictions are, fortunately, not important. If terms such as: "Almost as satisfactory," or "Slight effect upon tone quality," be taken as a criterion, it can be shown[8] that a frequency range from 60 to 10,000 cycles would be indicated.

The choice between ideal and restricted frequency ranges reduces to a balance between cost and performance. It appears, therefore, that the enthusiast must make his own decision as to the desirability of using less than ideal response.

Distortion

The allowable amount of distortion in a high-quality sound system is rather difficult to specify. The difficulty lies in the lack of any but general correlation between subjective and objective tests on distortions in sound reproducing systems.

Some idea of the subjective effects of distortion can be obtained from a study of the masking curves of the human ear. It will be seen, for instance: that the higher order harmonics are more easily discerned than the lower order harmonics; that the masking of harmonics increases as the signal level increases; that difference tones may be of more importance than the harmonics. With the complex

[1] "Olson and Massa: "J. Soc. Mot. Pic. Eng.," Vol. 23, No. 2, p. 65, 1934.
[2] Fletcher, H.: "J. Soc. Mot. Pic. Eng.," Vol. 22, No. 5, p. 314, 1934.
[3] Maxfield, Considine, Frichus: "J. Mot. Pic. Eng.," Vol. 30, No. 6, p. 666, 1938.
[4] Fletcher, H.: "J. Acous. Soc. Amer.," Vol. 13, No. 2, p. 89, 1941.
[5] "Bell Laboratories Record," Vol. 12, No. 10, p. 314, 1934.
[6] Snow, W. B.: "J. Acous. Soc. Amer.," Vol. 3, No. 1, Part 1, p. 155, 1931.
[7] See "Tanglewood Demonstrations," later in this article.

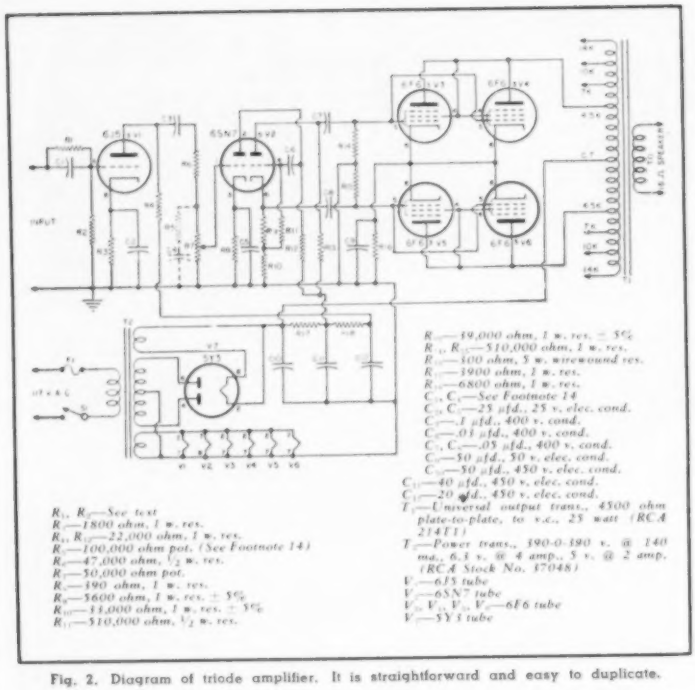


Fig. 2. Diagram of triode amplifier. It is straightforward and easy to duplicate.

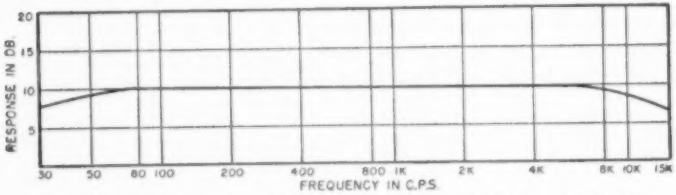


Fig. 3. Output response of amplifier for constant voltage at grid of the input tube.

waves of speech and music it becomes more difficult to speak, even in generalities. The amount of masking depends on the spectral distribution of the sound. A general idea can be obtained from a consideration of the masking effects of wide-band thermal noise. It is seen that at higher levels it becomes increasingly difficult to detect harmonics. The authors and their associates have reached a similar conclusion regarding the masking of distortion by higher level speech and music. Furthermore, it has been observed that the sensitivity of the ear to distortion in music appears to be a maximum for sound levels in the vicinity of 70 to 80 db.

If an attempt is made to evaluate the subjective effects of distortion, it immediately becomes evident that a continuous scale of values is impossible. Resort must be made to grouped gradations, such as; perceptible, tolerable, or objectionable. A perceptible level of distortion is dependent on experience and is, therefore, a fairly definite quantity. Tolerable and objectionable levels of distortion are dependent on personal opinion and are, therefore, very indefinite.

Obviously, the perceptible level of distortion can be used as an ideal—one can hardly ask for more than being unable to hear the distortion. For the type of distortion contemplated, for the frequency response contemplated, and for a sound level of 75 db., it has been shown* that a total r.m.s. distortion of approximately 0.75% is perceptible to critical listeners. This figure, therefore, is selected as the ideal for distortion performance. As pointed out before, the ear is not as critical at higher sound levels. It is probable, therefore, that this ideal figure can be relaxed for higher sound levels.

Any compromise with the ideal of distortion performance becomes so involved, with the items mentioned previously, that a single answer as to what constitutes tolerable distortion is unavailable. Distortions greater than ideal are most likely to occur at the higher power or sound levels. If it is assumed, for the moment, that ideal distortion performance can be achieved at intermediate (and lower) levels, then the concern is reduced to consideration of tolerable distortion at higher levels. It is the opinion of the authors that, for the type of reproduction contemplated in this article and for sound levels of 90 db., total r.m.s. distortions of 2 to 3% are tolerable.

Power Output

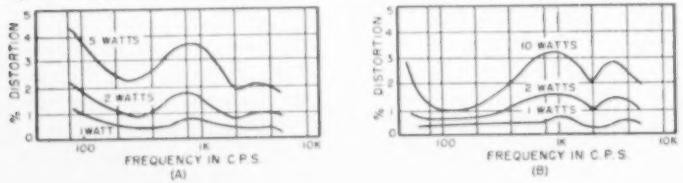
The electrical power input and sound power output of a loudspeaker are related by the efficiency of the loudspeaker. The electrical power requirements are, therefore, directly dependent on the sound level requirements.

Sound level requirements will vary, depending on individual tastes. It appears that, in the home, a habit pattern has developed from radio listening. It would seem that the radio volume control is adjusted so that speech is reproduced at ordinary conversational level and then no change is made as the program changes to music or whatever. Ordinary conversation has an average sound level of approximately 70 db. Opinion and scattered tests of sound levels found in home reproduction offer a figure ranging from 65 to 75 db.

Numerous demonstrations of high fidelity sound reproduction have been made to visitors to the *RCA Laboratories*. The demonstrations were made in the Living Room Laboratory which is representative* of a typical living room in a house or apartment. The average power input to the loudspeaker for these demonstrations was approximately 0.050 watt and resulted in an average sound level of approximately 80 db. This sound level has been objected to by some as being too loud, but never as being too low.

From the above, it would seem that an average sound level of approximately 75 db. would be adequate for most home reproduction. The power corresponding to this sound level would be approximately 0.016 watt.

Fig. 4. (A) Total harmonic distortion of the RCA 515S1 and (B) the RCA LC1A speakers.



*Olson, H. F.: "Elements of Acoustical Engineering," 2nd Edition, pages 488-491.

*H. F. Olson, "J. Acous. Soc. Amer.," Vol. 15, No. 2, 96-107, Oct. 1943.

For satisfactory performance, a sound reproducing system must be able to handle the power peaks encountered in speech and music. It has been established,[10,11] that the ratio between r.m.s. peak power and r.m.s. average power in speech and music is approximately 10 db. For an average power level of 0.016 watt the peak power would, therefore, be approximately 0.160 watt. Using round numbers and a moderate safety factor we have the surprising result that a ¼ to ½ watt amplifier would give satisfactory performance in many home installations.

There are, of course, many persons who desire the illusion of placing a large orchestra in their living rooms. Let us assume that the sound levels experienced in a concert hall for "full orchestra" from a large symphony orchestra will be adequate. It can be shown[12] that the peak sound level at a desirable seat in such a concert hall is not likely to exceed a value of 100 db. Extrapolating from the above figure of 0.050 watt corresponding to a sound level of 80 db. in an average living room, we deduce that peak sound levels of 100 db. would correspond to peak powers of 5.0 watts. It appears, therefore, that we are justified in limiting the power requirements of the amplifier and loudspeaker to approximately 5.0 watts.

Amplifier

The choice of an amplifier for a high fidelity sound reproducing system has become one of the most discussed problems in the audio field. A discussion of the problem immediately becomes involved with arguments, pro and con, concerning triodes, pentodes, feedback, power output, distortions, etc. To the innocent bystander, the consensus of these discussions, is an amplifier having, the more power the better, the lowest possible distortion at maximum power and, as a result, a disappointingly high cost.

The price of an amplifier depends on the performance required from the amplifier. Again, it seems proper, therefore, to insist only on that performance which is truly necessary. The necessary requirements for the amplifier are essentially the same as the system requirements set down before. It is very important to consider the distortion generated by the amplifier for the power level at which it will be most used. That power level would probably be of the order of ¼ watt and the distortion would be all the more important because of the increased acuity of the ear at the corresponding loudness level.

The selection of the amplifier configuration to meet the desired performance brings up the argument concerning triodes, pentodes, feedback, etc. It is generally conceded that the triode is superior to the pentode on a distortion basis. Consequently, the choice lies between the triode and the pentode with feedback. Triode amplifiers have been in commercial use for many years and, it would appear, have almost become a standard for comparison. It is claimed by many that pentode amplifiers with feedback can be made as good as or better than triode amplifiers. There is no reason to doubt this claim; however, it should be pointed out[13] that the price for the improvement to be obtained by feedback is the necessity of design control over a considerable frequency range below and above the useful frequency range of the amplifier. It is tacitly assumed here that the benefits of feedback will be required over the whole of the useful frequency range. The particular reasons for wanting to use a pentode derive from the improved power sensitivity and plate efficiency of such tubes. In an over-all sense these advantages are reduced, when feedback is applied. Negative feedback always reduces the over-all gain of the amplifier, and hence the advantage of power sensitivity of the pentode is reduced. The saving in power supply cost, in a pentode-feedback amplifier would be practically used up in supplying the necessary quality of components to allow the desired amount of inverse feedback.

Summing up, it appears that from a performance standpoint there is prob-

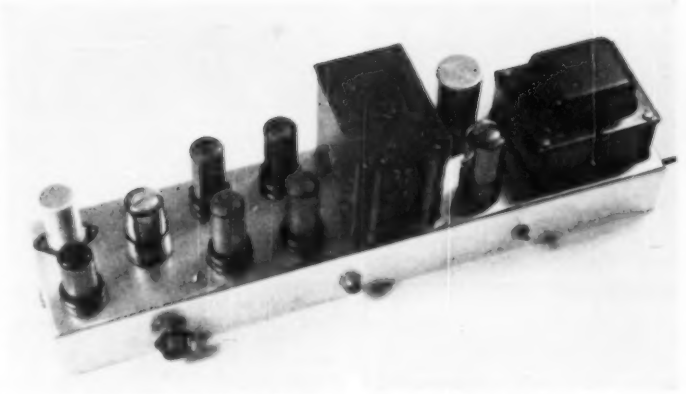


Fig. 5. Over-all top chassis view of the triode amplifier described in the text.

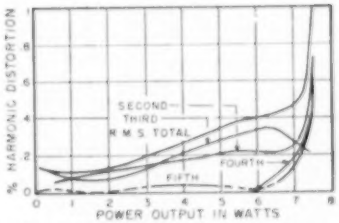


Fig. 6. The 2nd, 3rd, 4th and 5th harmonic distortion components and total r.m.s. harmonic distortion as a function of power output measured at 400 cycles.

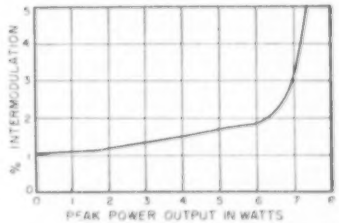
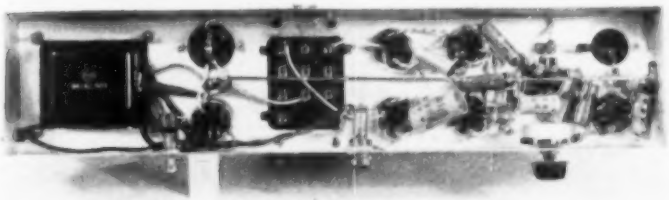


Fig. 7. Intermodulation distortion produced by combined inputs of 100 cycles and 2000 cycles. The amplitude of the higher frequency is one-fourth of the lower frequency. The curve shows total distortion, that is, the results have not been divided by 4.

★

Fig. 8. Under chassis view of the triode amplifier showing simplicity of wiring.



[11] Wolf, S. K. and Seitz, W. J., "J. Acous. Soc. Amer.," Vol. 2, No. 3, p. 384, 1931.

[12] Silvian, Dunn and White, "J. Acous. Soc. Amer.," Vol. 2, No. 3, p. 330, 1931.

[13] "Bell Laboratories Record," Vol. 12, No. 10, p. 314, 1934.

[14] Bode, H. W., "B.S.T.J.," Vol. 19, No. 3, p. 421, July 1940.

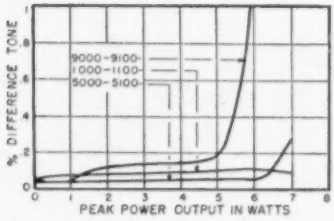


Fig. 9. Difference tone generation produced by an input of two h.f. components.

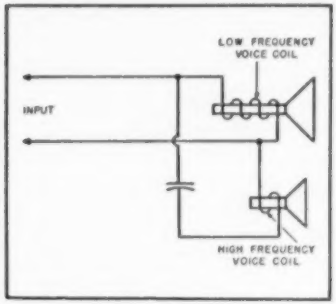


Fig. 10. Electrical crossover network of the duo-cone loudspeaker mechanism.

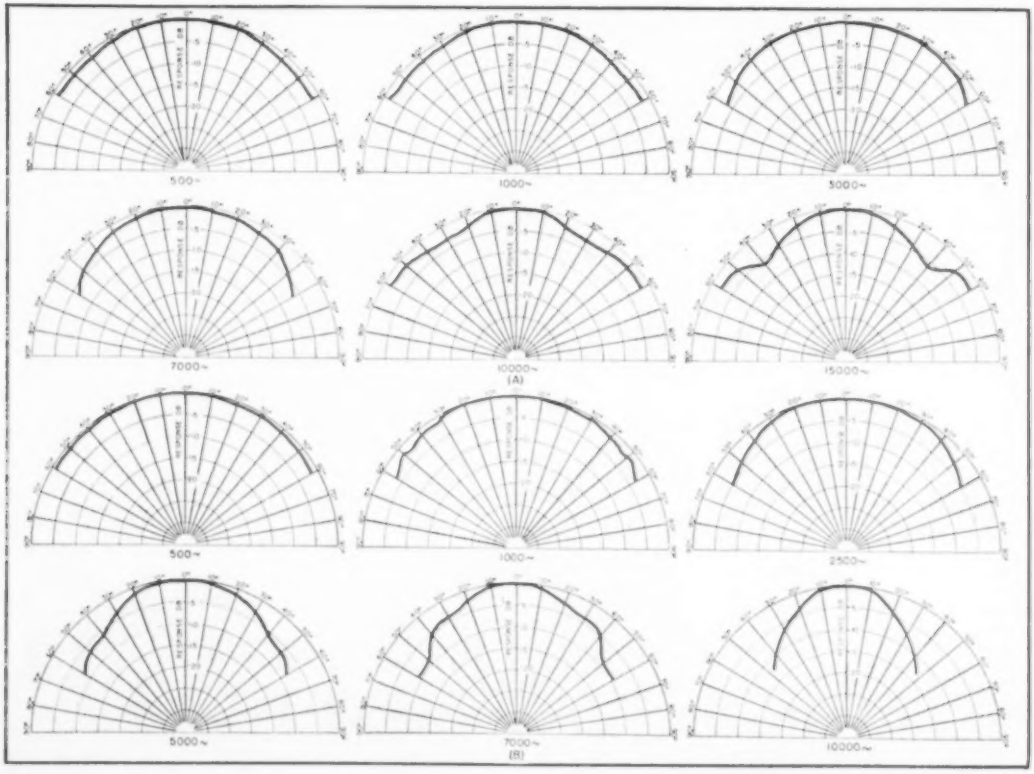
ably little difference between a triode amplifier and a *properly designed* pentode-feedback amplifier. From a custom design and construction standpoint the inherent simplicity of the triode amplifier is certainly to be preferred over the inherent complicacy of the pentode-feedback amplifier. There can hardly be any other conclusion than to recommend a triode amplifier for a custom type system, provided the desired performance is obtainable with the relatively few output triodes available.

A triode amplifier using readily available tubes and as simple a construction as possible has been developed. Photographs of the amplifier are shown in Figs. 5 and 8. The circuit diagram is shown in Fig. 2. The component specifications are given in the parts list.[14] The simplicity of the amplifier is obvious and also leaves little to be desired.

As can be seen in the following exposition of data, the amplifier performance is well within the specifications developed above. Fig. 6 shows the harmonic distortion of the amplifier for resistive loading for 400 cycle input. The distortion is shown on an individual harmonic and on a r.m.s. total basis. To be noted is the lack of higher order harmonics. For those who may be interested in the intermodulation distortion of the amplifier the results are shown in Fig. 7. The results of difference tone generation tests on the amplifier are shown in Fig. 9. The test consisted of introducing, to the amplifier, two equal primary voltages having a small difference in frequency. Then, the relative amplitudes of corresponding primary output voltages and the difference tone generated were determined by means of a wave analyzer. The result has been expressed as the ratio of the amplitudes of difference tone to either output voltage, in per-cent. The tests were conducted for primary voltage frequencies in the vicinity of 1000, 5000, and 10,000 cycles, and for difference frequencies ranging from 50 to 500 cycles. The power levels at which the tests were made are on the basis of the peak power obtained with the two primary voltages acting simultaneously. From a consideration of Figs. 6, 7, and 9, it

[14]Resistors R_1 and R_2 and C_1 are included for frequency compensation purposes and are discussed in the section on "Over-all System." If a high frequency tone control is desired, the dotted components may be added in shunt with the volume control. The 100,000 ohm tone control, R_3, should have a means for providing an open circuit at the maximum resistance end of rotation. The condenser, C_1, may have a value ranging from 1000 to 2000 micromicrofarads. The former value will provide a maximum attenuation, at 10,000 cycles, of 6 db. The latter value will provide 16 db at the same frequency.

Fig. 11. (A—Top two rows) Directional characteristics of the RCA LC1A speaker, and (B—bottom two rows) of the RCA 515S1 speaker.



is readily seen that the amplifier leaves little to be desired for output powers up to 5 watts. The frequency response of the amplifier is shown in Fig. 3. A comparison with the loudspeaker response shown in Fig. 15 proves the amplifier response to be adequate.

Loudspeaker Mechanism

Two duo-cone loudspeaker mechanisms were used for this reproducing system, namely the *RCA* LC1A[15] and the *RCA* 515S1.[16] The LC1A duo-cone is the custom-built deluxe loudspeaker mechanism covering the frequency range from 40 to 15,000 cycles with a broad directivity pattern and low distortion, while the 515S1 is the mass-produced loudspeaker with somewhat restricted performance characteristics. Both of these loudspeakers, as shown in the photographs of Figs. 12 and 13, use separately driven cones, a large cone for the reproduction of the low frequency range and a small cone for the reproduction of the high frequency range. The crossover frequency between the two cones is about 2000 cycles. The large voice coil, used to drive the large cone, exhibits sufficient inductance to adequately limit the current in the large cone in the high frequency region without the use of an auxiliary inductance. A condenser in series with the high frequency coil limits the current in the small voice coil in the low frequency region. The crossover network is shown in Fig. 10. The two cones are placed congruently so that in the overlap region the diaphragms vibrate as a single unit.

In the *RCA* LC1A mechanism separate magnets are used to energize the two air gaps. In the *RCA* 515S1 mechanism a single magnet is used to energize the small and large air gaps. A magnetic bridge arrangement allocates the appropriate amount of flux to each of the air gaps. In the 515S1 mechanism the outside suspension of the small cone is fastened to the large cone. A mechanical network is used to prevent interaction between the two cones. The small cone does not vibrate at the low frequencies because the inner suspension is much stiffer than the outer suspension. In addition, the space between the cones is vented in the large cone to prevent coupling due to the compliance of this volume. In the *RCA* LC1A the large and small cones have independent suspensions.

There are many possible sources of distortion in a dynamic direct radiator loudspeaker. A few of the most common sources of distortion are as follows: The suspension system; small rigidity in the cone; non-homogeneity of the air gap flux; and inadequate flux density in the air gap. Every effort was made to develop a loudspeaker system in which these distortions would be as low as possible without adding unduly to the complexity of construction, the sensitivity, or the cost.

[15] Olson and Preston: "RCA Review," Vol. 7, No. 2, page 155, 1946.

[16] Olson, Preston, Cunningham: "RCA Review," Vol. 10, No. 4, page 490, 1949.

Fig. 12. The RCA LC1A speaker mechanism.

Fig. 13. The RCA 515S1 speaker mechanism.

Cabinet

The cabinet shown in Fig. 14 has been found to be particularly suitable for the *RCA* Types LC1A and 515S1 mechanisms. The loudspeaker mechanisms are designed to be flush mounted with the face of the cabinet. Mounting the loudspeaker mechanism so that the front of the cone coincides with the face of the cabinet eliminates resonant and antiresonant effects which occur when there is a cavity in front of the mechanism. The cabinet is equipped with a port which may be used to accentuate the low frequency response if this type of characteristic is desired. The cabinet is lined with sound absorbing material, 1" thick, for the purpose of reducing standing wave systems within the cabinet which would react upon the loudspeaker and thereby produce a nonuniform response characteristic.

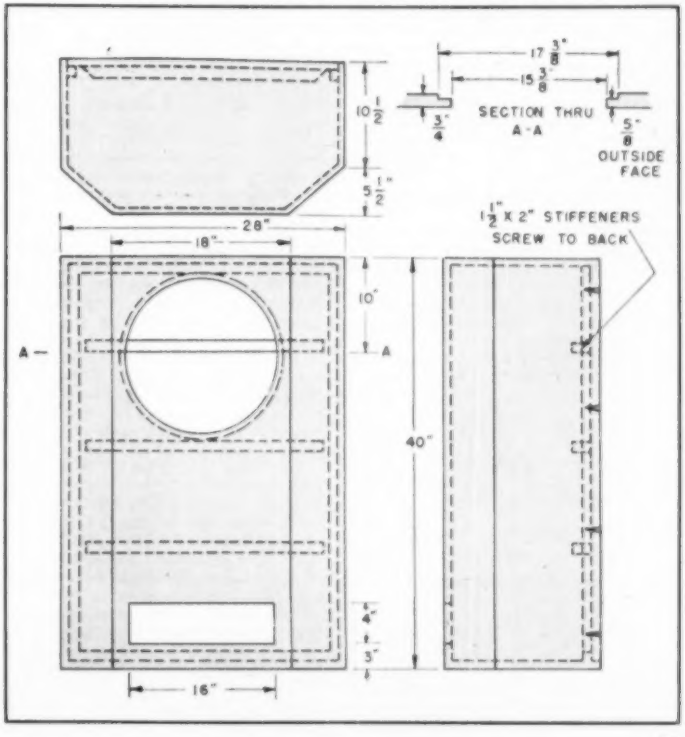
Loudspeaker Characteristics

The response frequency characteristics of the *RCA* LC1A loudspeaker mechanism, mounted in the cabinet of Fig. 14 and with the port opened and closed, is shown in Fig. 15B. It will be seen that uniform response can be obtained over the range from 40 to 15,000 cycles.

The directional characteristics of the

(*Continued on page* 140)

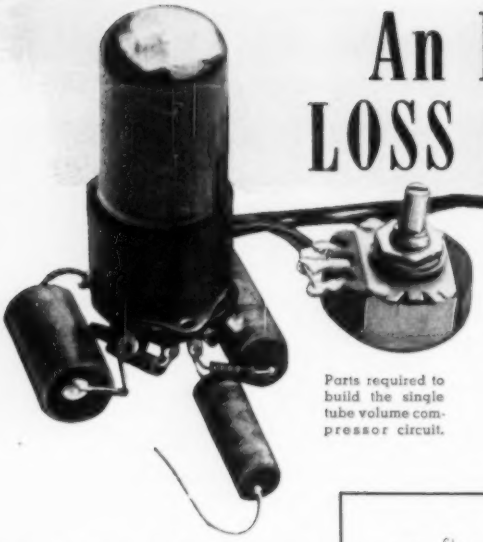
Fig. 14. Front, plan, and side views of the cabinet for housing reproducing system.



An ELECTRONIC LOSS COMPRESSOR

By
E. C. MILLER* and TAD JONES†

Basic circuit diagram of a new volume compressor using only one dual-triode tube. A deluxe model is also covered.

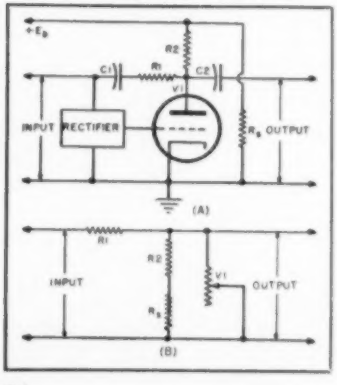


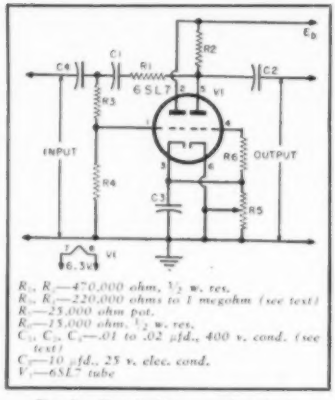
Parts required to build the single tube volume compressor circuit.

THIS article and the accompanying photographs describe and illustrate several units incorporating a new volume compressing circuit. This new unit requires only two tubes and is capable of 20 db. compression from 100 to 10,000 cycles with a change in output of ±1 db. over that range of input amplitudes and frequencies. The secret of its operation lies in the fact that the tube does not amplify, but instead is used merely as a variable resistance which is controlled by the amplitude of the input signal. This circuit, recently developed by *Northwest Radio Consultant Service*, permits constant output from amplifiers or test equipment where size, weight, or cost precludes the use of the common types of compressors.

Fig. 1A shows what is perhaps the simplest method of volume compression, where the input signal is rectified and the developed d.c. voltage is applied to the grid of V_1. As the signal increases in amplitude, the positive voltage on the grid increases, reducing the effective plate-cathode resistance of V_1. Fig. 1B shows the equivalent circuit of Fig. 1A. It can be seen that if R_1 is large and is nearly equal to R_2 plus R_3, and if the resistance of V_1 is made to vary over a wide range, the output signal can be held constant with considerable changes in input signal.

Fig. 1. (A) Circuit diagram of a simple method for obtaining volume compression. (B) The equivalent circuit.





R_1, R_2—470,000 ohms, ½ w. res.
R_3, R_4—220,000 ohms to 1 megohm (see text)
R_5—25,000 ohm pot.
R_6—15,000 ohms, ½ w. res.
C_1, C_2, C_4—.01 to .02 μfd., 400 v. cond. (see text)
C_3—10 μfd., 25 v. elec. cond.
V_1—6SL7 tube

Fig. 2. Circuit diagram of a single dual-triode volume compressor unit.

For linear compression it is necessary that the effective resistance of V_1 must vary logarithmically with respect to the applied signal voltage. In order to accomplish this, many things must be considered: First, the value of R_1, the plate load resistor, and R_2, the plate supply impedance at the frequency being considered, must be such that when combined with the plate resistance of V_1, the output will be reduced by the ratio of the increase in input amplitude. If the change in V_1 resistance were linear, this could only be accomplished for a small ratio of change, perhaps 3 or 4 db. It is evident then, that the change in V_1 resistance must approach the log of the change in input signal if the circuit is to compress to a constant output over an input range of 15 or 20 db. This could, of course, be accomplished by using logarithmic rectification with the necessity of further complicating the circuit.

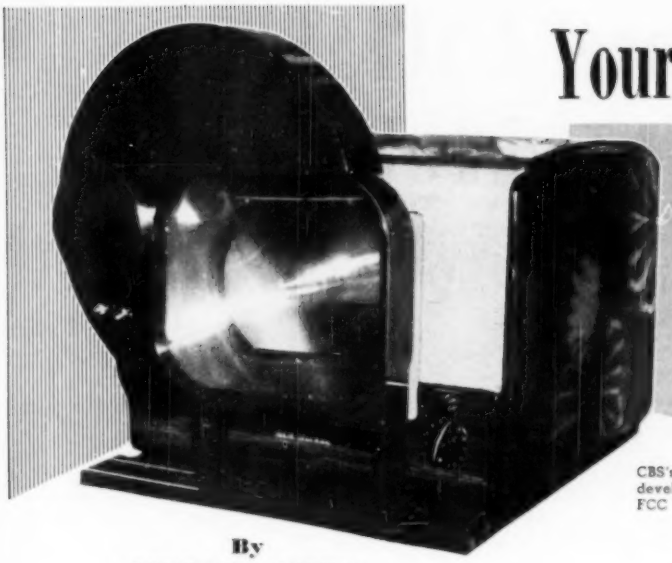
By the use of high impedance cathode detection, and the proper selection of R_6 in Fig. 2, logarithmic change is accomplished in the plate current of V_1 by the grid current drawn through R_6.

The complete theoretical design of this circuit is beyond the scope of this article, but for use at audio frequencies, the ratings of the components can be easily determined. C_1, C_2 and C_4 can be of the values usually used for coupling condensers such as .01 or .02 μfd. The other component parts are dependent upon the type of tube used, so for our design we will use a 6SL7GT. With this tube, which has low plate current, a plate load resistor of 270,000 to 680,000 ohms may be used. A value of 470,000 ohms may then be expected to give nearly optimum results when used at R_1. As noted earlier in this article, R_1 should equal R_2. The actual values of R_3 and R_4 aren't as important as the fact that they should be of equal value and be somewhere between 220,000 ohms and 1 megohm each. The logarithmic network (C_3, R_5, and R_6) can be calculated when the family of grid current curves is available, the lowest applied frequency is known, and several other factors are determined, but suffice it to say that with a 6SL7GT tube, R_6 should be 15,000 ohms, R_5 about 25,000 ohms maximum, and C_3 about 10 μfd. The values indicated will produce a unit capable of 15 db. compres-

(Continued on page 110)

* Chief Engineer, Northwest Radio Consultant Service, Havre, Montana.
† Chief Engineer, Radio Station KAVR.

Your Stake In The COLOR DECISION



CBS's color converter developed for early FCC color hearings.

By
MILTON S. KIVER
Pres., Television Communications Institute

The non-compatibility of the CBS system presents new problems for you, whether a set or shop owner.

WHAT may well be one of the most important decisions in the field of communications was handed down by the Federal Communications Commission on September 1, 1950. This was the long awaited FCC report on Color Television—a report that was preceded by two years of acrimonious hearings. In brief, the FCC indicates that it definitely favors the *CBS* system over the *RCA* or *CTI* systems. In the Commission's own words, "the *CBS* system produces a color picture that is most satisfactory from the point of view of texture, color fidelity, and contrast."

The decision, while not final, is the first definite word advanced by the FCC on color and may well represent the essence of the final decision.

In view of this inclination by the FCC toward the *CBS* color system, it is only natural to wonder how the adoption of this system will affect those who own sets now, those who service TV sets, and those who manufacture them. Each has a very substantial stake in the future of television and obviously this future lies with color television. For those readers not familiar with the details of the FCC report, reference should be made to "Spot Radio News" on page 16 where a detailed account of the report is given.

The choice of the *CBS* system came as a distinct surprise to many radiomen, especially in view of the fact that it is not compatible with the present black-and-white system. It will be remembered that much of the argument during the color hearings centered about two words: compatibility and adaptability. A color system is said to be compatible with the present black-and-white system if the color broadcast could be received and viewed on a black-and-white set without any circuit changes. Of course, the picture seen would be black-and-white, but it would contain all the detail of the color picture. The *RCA* and *CTI* systems fall within this category.

An adaptable color system is one whose programs could be viewed on black-and-white sets only after certain changes were made in the existing sets. The *CBS* system falls into this class. Because *CBS'* line frequency (29,160 lines-per-second) and field frequency (144 fields-per-second) differ from the line and field frequencies employed in current black-and-white receivers, *CBS* programs could not be received on the sets now in use without a change in circuitry.

For a complete review of the FCC COLOR DECISION see SPOT RADIO NEWS, Page 16

Now, what does the adoption of the *CBS* system mean to you, Mr. Set Owner? Present sets coming off the production line are designed to operate at a horizontal line frequency of 15,750 cycles-per-second and a field frequency of 60 cycles-per-second. Since these values differ appreciably from those found in the *CBS* system, certain changes would have to be made in your set before you could view *CBS* color programs even in black-and-white.

Your next question, of course, is: "How much would such a change cost?" The exact answer to this question cannot be given at this time because no such conversions have been made to date. FCC engineers have devised a circuit which shows what additional components would be needed and the cost of the parts alone runs between $10 and $17 depending upon whether manual or automatic switching is desired. To this figure would still have to be added the cost of labor. A tentative estimate might place the complete cost of conversion somewhere in the neighborhood of $35 to $40.

If, in addition, you wished to receive the color programs in color, the cost would rise considerably because now a motor and a color wheel (plus associated parts) would also have to be added. Some current industry estimates place this cost as high as $150; others say that $100 or perhaps slightly less will do the trick.

While we are on the subject of set conversion, here is one very important point to keep in mind. As the *CBS* system now stands, it cannot be used with picture tubes having diameters greater than 12½ inches because the color wheel would then become too large and unsightly. That means that if your present set has a picture tube larger than 12½ inches, it cannot be converted readily to receive color programs in color!! In time, it is hoped that a color tube will be available which will permit direct-viewing of *CBS* color pictures without a color

(*Continued on page 126*)

A 3-Channel UNITARY LOUDSPEAKER

Jensen's complete Triaxial System which includes a speaker and the crossover and control network.

By

D. J. PLACH & P. B. WILLIAMS

Physicist, Senior Eng., Jensen Manufacturing Company

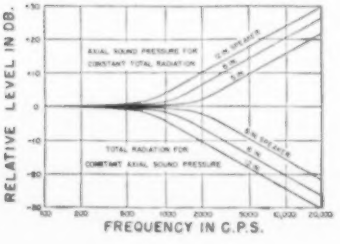
Performance details on the new Jensen G-610 Triaxial speaker and its associated networks.

WE ARE now in a new era of sound reproduction and radio transmission as a result of intensive research toward the development of better audio equipment. This trend has necessitated the development of improved loudspeaker systems capable of faithfully reproducing the bandwidth that has been made available by microphones and electrical equipment of advanced design. The *Jensen Manufacturing Company*, anticipating the continuation of the improvement trend, in 1948 launched an intensive research program to develop a loudspeaker for critical high quality applications. No restrictions were set on design or manufacturing cost, with the exception of ultimate size. The unit was to be compact, unitary, and suitable for mounting in enclosures ordinarily used for high quality reproducers. Many theoretical and subjective considerations led to the choice of three channels constituting the loudspeaker to be known as the G-610 Triaxial.

Laboratory tests have shown that a band from 40 to 15,000 cycles will transmit the full frequency range of music with good fidelity. The higher frequencies are necessary to bring out the fine overtone structure of musical instruments. Response curves themselves are by no means a complete measure of the performance of a loudspeaker. These curves are a guide in the development of loudspeaker systems when interpreted by trained acoustical engineers. Among many factors which are not apparent on axial sound pressure response curves are; spatial distribution, transient response, and harmonic and intermodulation distortion.

These factors, in conjunction with the frequency response, affect the subjective performance. Even though loudspeakers have similar response curves, it is a matter of common experience that they do not sound alike. Considerable differences in sound quality can be attributed to the other factors mentioned. To a large degree,

Fig. 1. Response of single cone speakers.



these considerations determine choice of crossover frequencies in multichannel systems.

Spatial distribution, sometimes called polar behavior, must be uniform at various angles from the axis of the speaker. If the polar pattern is irregular, the response balance will change as the listener moves off axis. A more desirable condition exists if the over-all pressure drops off axis while uniform response is maintained. Polar behavior of a conventional cone type loudspeaker is poor at high frequencies, while non-directional at low frequencies where the wavelength is large compared to the diameter of the cone. It has been shown that for a 12-inch loudspeaker in which the cone is assumed to act as a rigid piston over the entire range, axial sound pressure response must be raised 18 db. at 5000 cycles in order to maintain constant total radiation. If the speaker is designed this way, it becomes overly bright on the axis. If, on the other hand, a flat response on the axis is desired, the total radiation characteristic falls off by 18 db. at 5000 cycles, as illustrated by Fig. 1. This gives an indication of the polar sharpening that may be expected with a single cone. The use of elements such as directors, fins or other masses mounted upon the cone do not compensate for the definite limitations in performance of a single cone. Such elements, which actually add no true radiating area when fastened to the cone, can only add mass to the motor system which will only reduce efficiency and high frequency response. The polar behavior can be altered to some extent by proper processing of

the cone, with corrugations to vary the radial stiffness, but generally not to the degree necessary for highly critical applications. The best practice involves use of compression type driver units operating into properly designed horns for wide angle radiation at high frequencies.

Another major problem in high quality systems is distortion of both harmonic and intermodulation types. Intermodulation distortion is especially serious, since it results in sum and difference frequencies which are not harmonically related to the fundamental tone, and therefore can be especially displeasing to the ear. There are several sources of distortion in cone speakers. One cause is cone breakup at higher frequencies due to use of light cones without sufficient rigidity to suppress spurious modes of vibration. In this case, the whole cone does not move as a piston, and objectionable subharmonic modes are generated. Proper cone processing and sufficient cone mass are used to reduce flexing during operation. While this helps to decrease breakup difficulties, a better method in high quality systems is to restrict the operating range of the loudspeaker. In a woofer unit, the choice of a low crossover frequency is indicated.

Other forms of distortion can be caused by movement of the voice coil into regions of non-uniform flux density. The remedy here is proper design of the magnetic structure and voice coil so that the product of flux density and voice coil conductor length is a constant even at large operating amplitudes, as has been done in the G-610 low frequency channel.

The suspension system must be correctly designed in order to avoid non-linear stiffness effects which give rise to harmonic distortion. At the resonant frequency of the moving system, mechanical impedance reaches a minimum and the cone attains its maximum movement. Greatest distortion accordingly occurs at this frequency, because around this region the suspension system is the controlling factor. Over-all effect on the performance of the speaker can be minimized by placing the resonance of the loudspeaker at as low a frequency as possible, consistent with axial constraint necessary for stability. Use of a compliant cone annulus and a large spider help to lower the resonant frequency. Some loudspeakers are designed with non-linear suspension systems for the very purpose of giving rise to high distortion which may give greater apparent loudness. Yet on critical listening over a period of time, it can be seen that this type of loudness boost is not desirable, as the sound is characterized by "muddiness."

It is also possible by use of magnetic fields of low energy levels, and more so in the case of speakers coupled to amplifiers of high internal impedance, to produce a false bass response due to undamped vibrations of the cone. The resulting "hangover" effect prevents clean bass response. In some cases, damping is attained by use of solutions giving soft, absorbent coatings at the cone annulus. The better method is through use of magnetic damping of the vibrating system. This method, while costly, gives better damping characteristics over the whole frequency range, in contrast to selective damping effects from coatings. High magnetic energy required for good magnetic damping, in addition to minimizing spurious modes over the entire operating band, and improving transient performance, results in higher loudspeaker efficiency as well.

These considerations served as a guide in the development of a woofer for the G-610 Triaxial. Incorporated in this channel are a magnetic circuit providing 30 million ergs energy from a 6½ pound Alnico V magnet, and an unusually large voice coil, three inches in diameter. The extremely high magnetic efficiency achieved makes the choice of amplifier internal impedance non-critical from the standpoint of loudspeaker damping.

A moderately stiff 15 inch diameter cone minimizes breakups even at high power levels over its operating band. The breakup problem would not be serious, however, because of the low crossover frequency of 600 cycles used, beyond which energy is transferred to other channels. A heavy machined aluminum cone housing carries the iron structures for the three channels.

Numerous possibilities were investigated for high frequency reproduction, including secondary radiators such as thin metal domes coupled to the woofer voice coil. Investigation of many commercial adaptations of these domes disclosed spurious modes of response and poor transient characteristics. While this method is common to lower priced loudspeakers and perhaps satisfactory in narrow range systems, it was considered highly unsatisfactory for a high quality reproducer.

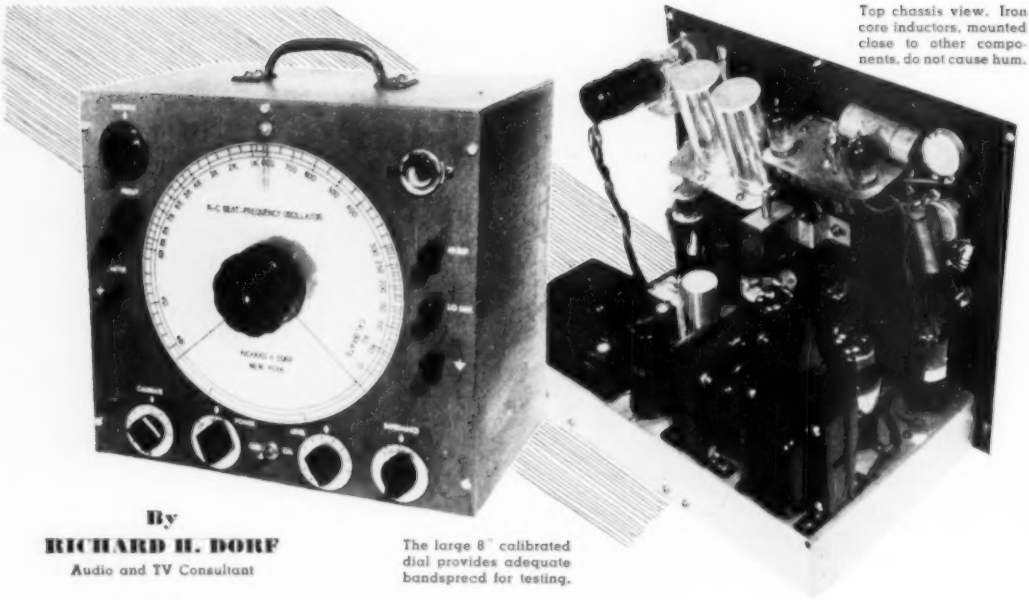
Two additional horn type driver channels were designed to complete the coverage of the desired range, for it is not theoretically or experimentally possible to cover the full auditory range satisfactorily from 600 cycles up with only one channel. The requirements for efficient reproduction over a wide bandwidth in the upper register are contradictory. At frequencies approaching the lower limit of 600 cycles, a sturdy moving system and large air chamber clearances are necessary, whereas at the high frequencies, where the program energy is less and amplitudes are smaller, small clearances and very light moving systems are required for efficient operation. These opposing requirements dictated the use of two channels to cover the range from 600 cycles up. Horn type drivers were chosen in preference to direct radiator, or cone type, units, for a number of reasons:

(1). For a given magnetic energy, the additional loading given by a horn makes it possible to obtain much higher efficiency.

(2). Properly designed horns give good loading down to cut-off frequency, thereby reducing diaphragm movement necessary for a given amount of radiated power. This eliminates distortion effects caused by motion of the voice coil out of the magnetic gap and by non-linear stiffening

(*Continued on page* 120)

Rear view of the complete G-610, three-way Triaxial System. Network chassis is shown mounted on baffle but may be located on side or bottom of cabinet. The high frequency and level controls may be mounted flush on the outside of the cabinet housing the unit.



Top chassis view. Iron core inductors, mounted close to other components, do not cause hum.

The large 8" calibrated dial provides adequate bandspread for testing.

By
RICHARD H. DORF
Audio and TV Consultant

An RC Beat-Frequency OSCILLATOR

Excellent frequency stability and constant output characterize this unit which covers 5-19,000 cycles.

IT WOULD seem that in this day and age the perfect audio test generator should have been invented long ago. Certainly many magazine articles have been written on various versions of the two principal types—the beat-frequency oscillator and the *RC*-tuned fundamental-frequency generator. In their common forms, however, neither of these two types solves the problem entirely, at least for general experimental work.

Certain fundamental problems defy simple solution. An r.f. test generator, for instance, need rarely cover a range in frequency of more than two or three to one, which is easily done with a standard tuning condenser. When the range is greater, switching is used; since no single use for such a generator involves more than a single range, switching causes no problem of continuity between ranges.

In audio, on the other hand, any one use of the oscillator usually calls for tuning over the entire range between at least 50 and 10,000 cycles, a range of 200 to 1, and sometimes from 20 to 20,000, which is 1000 to 1. No wonder there is a problem!

The most popular oscillators today use Wien bridge circuits which oscillate at the fundamental frequencies. Few tuning condensers, however, have ranges of capacitance greater than about 10 to 1, so three switched bands are necessary. Of itself this would not be a serious fault but it introduces at least one other fault—discontinuity in the output level. When, for instance, 200 cycles is at the upper end of the first range and the switch is turned to the second range to continue the run, the output level usually changes abruptly. Unless the output is measured continuously, therefore merely switching bands introduces an error in a frequency run. In the best of the *RC* oscillators, level is usually kept in line within ±1 db. or so. But because it is likely to change most with a change from minimum to maximum tuning capacitance, switching bands like this makes an abrupt change in the graph line of the readings and is confusing.

A second fault of the *RC* unit is the fact that it rarely has sufficient overlap. Experimenters must often determine quickly the resonant frequency of some network or other. If that frequency happens to fall at the extreme end of one range there must be a continual switching of ranges plus precise measurement and recording of output from the tested circuit before the peak-output frequency is apparent.

A third shortcoming of the Wien bridge oscillator is very apparent in some poorly built instruments. Because of either a large time constant or a slow-heating stabilizing lamp in the automatic gain control circuit, the operator must wait for a second or two each time he changes frequency for the output to come up or down to normal. The effect is made worse by poor adjustment of the feedback control, an adjustment which is extremely touchy at best. No one adjustment, in any case, is satisfactory at both the highest and the lowest frequencies.

Beat-Frequency Oscillators

The beat-frequency oscillator does not have the faults of the fundamental-frequency type. Its continuous tuning allows for no discontinuities in level and, at least in a well built unit, the level is inherently constant since the variable oscillator is tuned over only a small range—never even as much as 2 to 1. Obviously, range overlap is no problem as there are no ranges to switch. It may have a slightly less perfect output waveform, however, due to distortion in the detector. It is more elaborate than the *RC* oscillator, requiring at least three

tubes against a minimum of one duotriode for its "opponent."

The principal disadvantage of the beat-frequency oscillator is the fact that a small percentage drift in the frequency of either of the r.f. oscillators causes a very large drift in the a.f. output. Some means of calibration must be built in and the instrument may not be used for some minutes after it has been turned on.

As a construction project, the beat-frequency oscillator is much less popular than the *RC* unit mainly because it requires such good shielding. Two oscillators operating near the same frequency tend to lock in step. Without good shielding, the oscillators would lock suddenly when they came as close together as a few hundred cycles (assuming they were operating at around 100 kc. or more), which means that to obtain low-frequency a.f. output, shielding must be better than the average constructor cares to worry about. Placement of components also affects locking. As in the *RC* oscillator a variable condenser (usually two) is needed and it is subject to strays and hum pickup.

Combining the Two Types

In an effort to design a generator which would overcome some of the problems of both types the writer combined them so as to make use of the best features of each. The result is a beat-frequency oscillator having continuous frequency coverage but with no coils to radiate r.f. and consequently no shielding.

Performance-wise, this *RC*-tuned beat-frequency oscillator covers a range from 10 to a little over 19,000 cycles. The easily reproducible tuning dial has an effective scale length of 18 inches so that all frequencies may be read easily. Though 10 cycles is the lowest calibration, the unit reaches about 5 cycles with good stability, showing how little locking effect there is between the two oscillators. Output level is flat without measurable variations over the entire range and waveform appears excellent on the oscilloscope, though no harmonic distortion measurements have been made. The frequency becomes stable enough to use after three to four minutes of warmup and does not drift noticeably after seven or eight minutes.

Circuit Design

The particular instrument constructed by the writer is illustrated in the photographs and diagrammed in the schematic. It is more elaborate than some constructors will find necessary, but the essential elements—a three-tube circuit—may be used with or without additional embellishments.

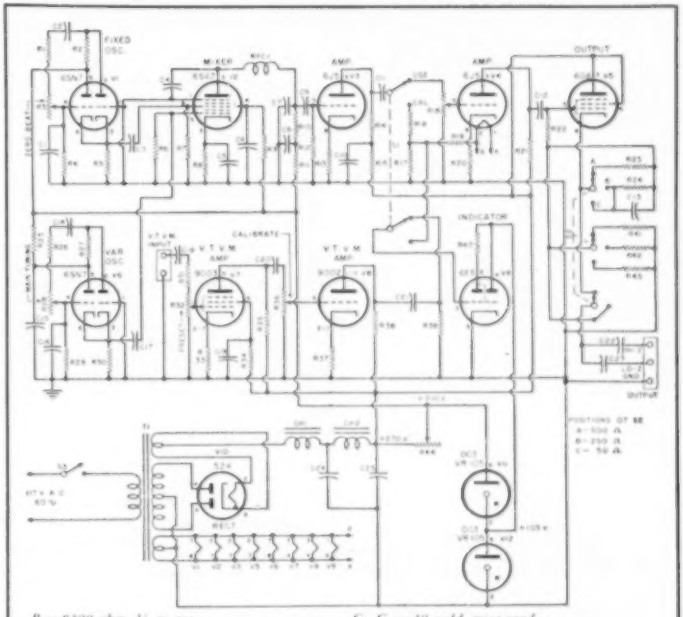
The two high-frequency oscillators which beat to produce the audio resultant are V_1 and V_2 in the diagram, a pair of 6SN7GT's. Each oscillator requires a grand total of only two resistors and no condensers, excluding the tuning components.

The cathodes of the two triodes in each 6SN7GT are tied together and grounded through a common resistor. The first triode acts as a cathode follower coupling the signal to the cathode of the second triode, which is a grounded-grid amplifier. This arrangement is sometimes used as a phase inverter in normal amplifiers and that is exactly why it is used here. The voltage amplification required for a Wien bridge oscillator is only 3, which could be adequately supplied by a single triode; but the amplifier output must be in phase with the input so an inverter is necessary. This is the simplest possible circuit.

For the fixed oscillator, the frequency-determining network consists of C_1 and the combination of R_1 and R_2 in series, plus the parallel combination of C_1 and R_3. A small section of the series resistance (R_2) is made variable for calibration purposes. The tuning components in the variable oscillator are C_{1a}, R_{2a}, R_{3a}, C_{1a}, and R_{3a}. In this case, most of the series resistance is variable (R_{2a}) to provide a main tuning control.

The cathode and plate resistor for each oscillator is so proportioned as to just allow oscillation, which makes for maximum stability and minimum distortion. The oscillators operate at about 60 kc. The variable tunes up to about 80 kc., a total range of only 1.4 to 1, so feedback conditions do not change appreciably over the entire audio range and no stabilizing lamp is necessary. When R_{2a} is at minimum resistance the output waveform of the variable oscillator is

Complete schematic diagram of the RC beat-frequency oscillator. Oscillator tuning components may require some trimming which may be determined by experimentation.



R_1—8100 ohm, ½ w. res.
R_2, R_{2a}, R_{2b}—70,000 ohm, ½ w. res.
R_3—500 ohm carbon pot. (Clarostat)
R_4, R_{3a}—16,000 ohm, ½ w. res.
R_5, R_{3b}—1800 ohm, ½ w. res.
R_6, R_7, R_8, R_{11}, R_{22}, R_{28}—47,000 ohm, ½ w. res.
R_9—500 ohm, ½ w. res.
R_{10}, R_{20}, R_{26}—100,000 ohm, ½ w. res.
R_{12}, R_{23}, R_{29}—1000 ohm, ½ w. res.
R_{13}—15,000 ohm, ½ w. res.
R_{14}—62,000 ohm, ½ w. res.
R_{15}—40,000 ohm, ½ w. res.
R_{16}—100,000 ohm pot.
R_{17}—68,000 ohm, ½ w. res.
R_{18}—7500 ohm, 2 w. res.
R_{19}—250 ohm, 1 w. res.
R_{21}—2500 ohm, ½ w. res.
R_{24}—2800 ohm, ½ w. res.
R_{25}—10,000 ohm pot., audio or logarithmic taper (Clarostat)
R_{27}, R_{30}, R_{31}—1 megohm, ½ w. res.
R_{32}—10 megohm pot.
R_{33}—470 ohm, ½ w. res.
R_{34}—190,000 ohm, ½ w. res.
R_{35}—200,000 ohm pot.
R_{36}—1900 ohm, 2 w. res.
R_{37}—150 ohm, 1 w. res.
R_{38}—36 ohm, ½ w. res.
R_{39}—3000 ohm, 10 w. wirewound adj. res.
C_1, C_{2a}, C_{2b}, C_{3a}—100 μμfd. mica cond.
C_{2a}, C_{3a}—20 μμfd. mica cond.
C_3, C_4—.001 μfd., 400 v. cond.
C_{3a}—1 μfd., 200 v. cond.
C_5—2 μfd., 350 v. elec. cond.
C_6—16 μfd., 350 v. elec. cond.
C_7, C_{11}, C_{12}, C_{20}—.5 μfd., 400 v. cond.
C_8—10 μfd., 350 v. elec. cond.
C_9—250 μfd., 15 v. elec. cond.
C_{10}, C_{19}—.1 μfd., 400 v. cond.
C_{13}—.01 μfd., 400 v. cond.
C_{14}—.25 μfd., 400 v. cond.
C_{15}—2 μfd., 200 v. cond. (See text)
C_{16}—160 μfd., 450 v. cond. (See text)
C_{17}, C_{18}—20 μfd., 350 v. elec. cond.
RFC—50 mhy. r.f. choke
S_1—D.p.d.t. toggle sw.
S_2—1-pole, 3-pos. sw.
S_3—S.p.s.t. sw.
T_1—Power trans. 350-0-350 v. @ 90 ma.; 6.3 v. c.t. @ 3 amps.; 5 v. c.t. @ 2 amp.
CH$_1$, CH$_2$—8 hy., 150 ma. filter choke
V_1, V_2—6SN7 tube
V_3—6SA7 tube
V_4, V_5—6J5 tube
V_6—6G6 tube
V_7—9004 tube
V_8—9002 tube
V_9—6E5 tube
V_{10}—5Z4 tube
V_{11}, V_{12}—OC5/VR105 tube

somewhat distorted but it has much less effect on the detector output than the fixed oscillator, whose output remains nearly harmonic-free.

The detector or mixer is a 6SA7. The input signal coupled to the No. 3 grid (that from the fixed oscillator) has a much greater effect on the plate current than that coupled to grid No. 1 (the variable oscillator).

The plate circuit of the 6SA7 contains an *LC* filter which attenuates the r.f. and allows the audio to pass. C_4 and C_5 with the 50 mhy. r.f. choke make up a low-pass constant-k filter which cuts off at approximately 30 kc. R_{10} is the plate load resistor with R_{11} and C_6 a decoupling filter. Audio output is taken through C_8.

The parts discussed above are the heart of the instrument and may be used with any kind of amplifier.

The instrument in its final form includes a cathode-follower-output amplifier and a vacuum-tube voltmeter as well as a built-in power supply.

The amplifier has three stages, the first two of which, V_3 and V_4 are conventional triode voltage amplifiers (a single 6SN7GT could have been used). The output level control R_{13} is between the two. Unbypassed cathode resistors help in keeping the input resistance high and capacitance low to avoid frequency discrimination.

The output tube was chosen for its ability to deliver a usefully high voltage when used as a cathode follower. An ordinary low-level triode would do just as well if the cathode follower fed a high impedance. In this case, however, the oscillator was designed to feed 500/600 lines and 250 and 50 ohm amplifier inputs. When a cathode follower is correctly matched to *and loaded by* such low impedances, the feedback in terms of actual voltage is so low that the permissible input voltage and gain are greatly reduced unless plate-supply voltage is boosted considerably.

Distortionless output voltage is limited to about 4 volts into 500 ohms, 0.6 volt into 250 ohms, and 0.5 volt into 50 ohms. These values are sufficiently high for almost any purpose.

The cathode follower circuit is different for each of the three impedances. In all cases the grid return is placed between two series cathode resistors since the optimum bias resistor is smaller than the total necessary load resistance for 500 ohms and larger for the lower impedances, in which case it is bypassed by C_{15}. Output is taken directly from the cathode for 500 ohms and from the junction of the two resistors for the lower values, though it could have been taken from the cathode for all loads.

S_2 is a wafer switch whose three positions select the correct resistors and feed output through C_{23} to the low-impedance terminal. C_{23} is made up of a pair of *Cornell-Dubilier* UP-type condensers, each of which is a dual 40 μfd. at 450 working volts. Since the cathode voltage (d.c.) is 130 in the 500-ohm position it is essential that d.c. leakage be low to avoid transferring current to the device under test. These condensers were chosen for low leakage after a number of tests. Current transfer into a 500 ohm (resistive) load is less than 50 microamperes.

High-impedance devices may be fed by the same cathode follower with the advantage that the cathode impedance keeps the line impedance so low that hum and noise pickup is negligible even when the distance between the oscillator and the device is great. In this case, however, no d.c. at all may usually be tolerated, as it might change the bias if applied to a grid. For this reason, a high-impedance output is provided by taking signal from the cathode through a 2 μfd. metallized paper condenser to a separate terminal. The 2 μfd. value makes it possible to feed impedances as low as 5000 ohms without any falling off of bass down to the oscillator's minimum calibrated frequency of 10 cycles.

When feeding a high-impedance device, the impedance switch is set on the 500 ohm position. Maximum undistorted output voltage is about 28, open circuit, and only slightly less when loaded down to 5000 ohms. The three stages are so designed that the volume control may be opened fully to obtain this voltage.

Indicator Circuits

At least one indicator circuit is needed in any beat-frequency oscillator—for calibration—and an additional one, a vacuum-tube voltmeter, is provided here to measure the output of devices under test. Both use a 6E5 electron-ray tube.

Except on extremely expensive oscillators, an indicator that calibrates by showing when the two oscillators are at the same frequency is unsatisfactory because the indication is too broad for accuracy. Despite the usual shielding the oscillators will lock when very close. It is more satisfactory to calibrate by setting the instrument for an audio output of 60 cycles and beating that with the power-line frequency, which is very accurate in most localities.

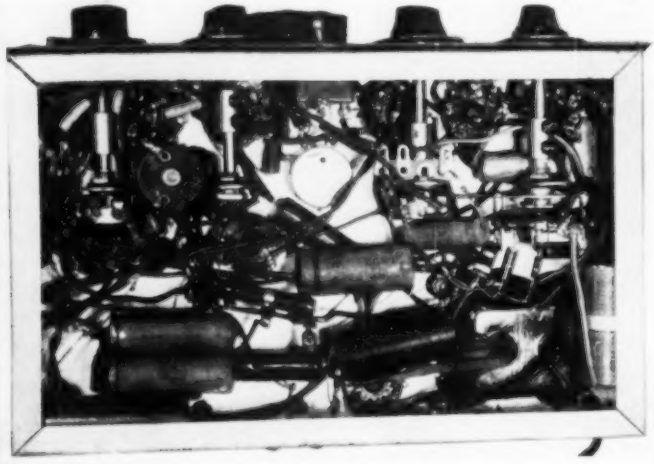
The simplest circuit is used. S_1, a d.p.d.t. toggle switch is shown in the diagram in the "Use" position. To calibrate, it is thrown to the "Calibrate" position. The output of V_5 then goes to R_{14} and R_{17} in series to ground as a voltage divider. At the junction of the two resistors is connected one side of the center-tap-grounded filament winding of the power transformer. The same junction is connected through a section of S_1 to the grid of the 6E5. When line and oscillator audio frequencies are equal (adjustment is made by the zero beat control of the fixed oscillator) the 6E5 shadow angle stays constant. With very small differences it opens and closes very slowly, while at other frequencies it appears to remain closed.

The vacuum-tube voltmeter does not read directly in volts but merely in decibels above and below a variable (uncalibrated) reference. The v.t.v.m. input terminals are connected across the correctly terminated output of the device under test. The preset potentiometer is then set so that with R_{18} at the zero-decibel mark the 6E5 shadow just closes. For each change in v.t.v.m. input level caused by frequency discrimination in the tested unit, R_{18} is reset so that the shadow again just disappears and the decibels gain or loss is read from the R_{18} dial.

The minimum signal handled by the voltmeter is less than 10 mv., so that the lowest-level stages can usually be measured. High-level devices merely require that the R_{18} setting be low. Input resistance of the meter circuit is 11 megohms with sufficiently low

(*Continued on page 165*)

Under chassis view. Although wiring appears crowded, the unit functions satisfactorily.



An Unusual PUBLIC ADDRESS SYSTEM

Over-all view of compact p.a. amplifier. Note that output transformers are isolated from input transformers by the greatest possible chassis separation.

By
GLEN SOUTHWORTH

This 20 watt amplifier features voltage multiplier power supply and two low impedance input circuits.

IN JUDGING the over-all utility of a particular electronic device it is often necessary to consider factors other than strictly electrical characteristics. This seems to be particularly true of equipment such as public address amplifiers, which may be used for a number of different purposes in a wide variety of situations. In the case of equipment which is continually being moved from one location to another, physical characteristics are of definite importance, with size, weight, and mechanical strength being some of the primary considerations. In the case of the conventional public address amplifier, several factors tend to produce undesirably large physical dimensions. One of these factors is the need for isolating input and output stages in a high gain system. This is often done by resorting to mere spatial separation rather than by the use of shielding. Another factor is the bulk of the amplifier components themselves. Providing adequate area for sufficient heat radiation, thus increasing the service life of the various amplifier components is an additional requirement. Another possibility is that a particular amplifier may contain circuit elements not strictly necessary for a particular application.

In practice, a worthwhile reduction in size and weight, without sacrifice of electrical performance, may be achieved by minimizing the above mentioned factors whenever possible, consistent with other considerations such as reliability of performance and ease of maintenance, both of which are important factors in professional public address work.

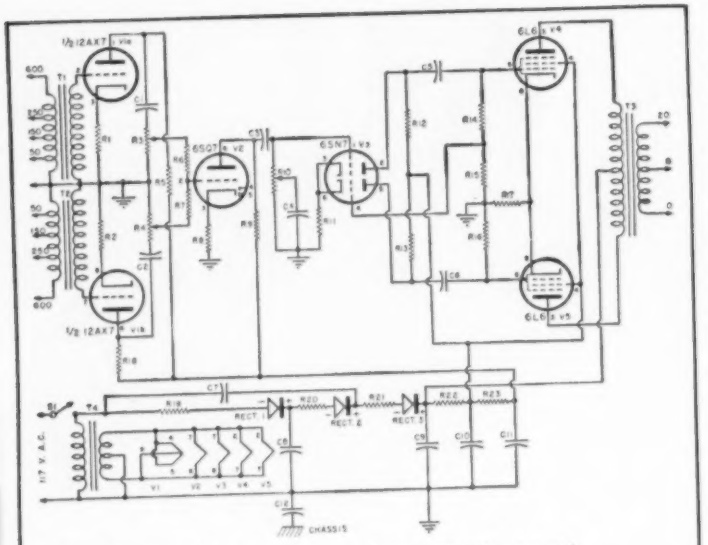
In conventional amplifiers a large part of the weight, bulk, and heat radiation comes from the power supply. In some cases the power supply alone may occupy half of the amplifier chassis. In addition, the mounting of heavy components, such as the power transformer, on the chassis may lead to severe mechanical stress which, in the case of a light chassis, may lead to a rupture of spot welds as well as undue strain on circuit wiring or other components.

A very worthwhile reduction in physical dimensions, heat radiation, and weight, as well as somewhat greater economy, can be obtained through the use of selenium rectifiers in a voltage multiplier circuit. In the circuit diagram shown, a simple voltage tripler is sufficient to supply 360 volts d.c. to the plates of push-pull 6L6's operated in class AB$_1$. Basic power supply requirements are, therefore, reduced to three 150 ma. selenium rectifiers, three electrolytic filter condensers, and a small 6.3 volt filament transformer. Likewise, extra ruggedness and longer life are obtained by eliminating the conventional rectifier tube.

The output voltage of a multiplier system will depend upon the load resistance and the size of the condensers used in the multiplier circuit. With the 30 μfd. condensers shown in the schematic the tripler will supply 100 milliamperes at approximately 360 volts to the 6L6 plates. Under maximum sine wave signal the voltage dropped to about 330 volts. The regulation could be improved by use of larger condensers but it was noted that under conditions of maximum undistorted output for complex sounds, such as speech, that the plate voltage change was much less. If desired, however, an additional voltage doubler stage might be included to supply well regulated voltage to the screen grids of the 6L6 tubes.

It should be realized that the voltage multiplier type of power supply has the disadvantage that one side of the a.c. line is connected to the electrical ground of the circuit. This is a situation found in many pieces of electronic equipment, particularly small radio sets, but it is wise to take precautions to prevent possible shock or short circuits. The simplest way of doing this is to insert the a.c. plug into the outlet in such a position as to connect the chassis to the neutral side of the line. Where polarized outlets are not available, polarity may usually be determined with a small neon testlight. One of the testlight leads is grasped by the bare fingers and the other lead touched to some exposed portion of the chassis. If the chassis is "hot," body capacity will make the testlight glow, and when the a.c. plug is reversed the glow should disappear. An additional precaution is taken in the amplifier circuit shown, i.e., that of isolating the chassis and microphone inputs from the electrical ground of the circuit. The only connection between the chassis and the rest of the circuit is a .25 μfd. condenser which greatly reduces the possibility of accidental short circuit but may lead to a somewhat greater hum level in some installations.

Turning to the power output stages of the amplifier, a number of factors might be noted. A high-grade output transformer was used, both from the standpoint of greater efficiency and the availability of a clean, wide range signal, thus making the amplifier useful for a number of applications. An-



R_1, R_2, R_3, R_{15}—1500 ohm, ½ w. res.
R_4, R_{17}—500,000 ohm pot.
R_5, R_6, R_{12}, R_{13}, R_{14}, R_{16}, R_{18}—100,000 ohm, ½ w. res.
R_7, R—500,000 ohm, ½ w. res.
R_{10}—250,000 ohm pot. (with sw. S_1)
R_{11}—5000 ohm, ½ w. res.
R_{19}—250 ohm, 10 w. wirewound res.
R_{20}, R_{21}, R_{22}—5 ohm, 1 w. res.
R_{23}—5000 ohm, 10 w. wirewound res.
R_{24}—25,000 ohm, 1 w. res.
C_1, C_2, C_3—.02 μfd., 400 v. cond.
C_4—.01 μfd., 400 v. cond.
C_5, C—.1 μfd., 400 v. cond.
C_7—10 μfd., 300 v. elec. cond.
C_8—30 μfd., 150 v. elec. cond.
C_9—30 μfd., 450 v. elec. cond.
C_{12}—12 μfd., 450 v. elec. cond.
C_{13}—8 μfd., 450 v. elec. cond.
C_{14}—.25 μfd., 600 v. cond.
S_1—S.p.s.t. sw. (on R_{10})
T_1, T—Input trans. Mic. or line-to-grid. Pri. 50/150/250/600 ohms; Sec. 50,000 ohms (Chicago Transformer BF-7)
T_2—Output trans. 25 watts, 7500 ohm plate-to-plate to 8/20 ohm v.c., p.p. 6L6's (Chicago Transformer BO-6)
T_3—Fil. trans. 6.3 v. @ 3 amps. c.t. (Chicago Transformer F-633)
Rect. 1, Rect. 2, Rect. 3—150 ma. selenium rectifier
V_1—12AX7 tube
V—6SQ7 tube
V_2—6SN7 tube
V_3, V_4—6L6 tube

Complete schematic of the twenty-watt p.a. amplifier and its associated power supply.

other circuit feature of considerable importance is the use of low value grid resistors for the 6L6's. This tends to greatly reduce the buildup of small grid potentials on the order of a volt or so which may tend to block low level signals, giving the reproduction a "mushy" effect. The difference in quality between .1 and .5 megohm is often readily noticeable in listening tests, with considerable amounts of inverse feedback being required to achieve comparable cleanness of reproduction with the higher value of grid resistance. Another factor of interest is that due to the high quality of the output transformer employed, no condenser is used between the plates of the 6L6's. This is desirable in that any appreciable capacity across the plates may produce impulse distortion with the result that needle scratch or similar sounds are made more audible. Likewise, ceramic sockets are used in the output stages in order that the full output of the amplifier may be used without danger of high voltage arc-over to ground.

It should be noted that no cathode bypass condensers are used in the amplifier circuit. In the voltage amplifier stages these are optional, but in the output stage it was considered worthwhile to eliminate the cathode bypass in order to generate a certain amount of out-of-phase third harmonics, which tend to make the system less critical with regard to "breaking up" when used at maximum levels, such as may be required in public address service.

The phase inverter used is of conventional design, while the mixer stage uses a single triode instead of the more common dual tube arrangement. In this type of mixer the outputs of the two volume controls are fed into the same grid through 500,000 ohm isolating resistors. This has the slight disadvantage that the gain is somewhat reduced and increasing the gain of one channel will tend to increase the gain of the other channel by a small amount. However, a circuit of this nature has the advantages of simplicity and lower distortion as well as the fact that high frequency response is virtually the same at all settings of the volume control, due to the relatively small grid-to-ground capacity. Due to the series grid resistances in the mixer circuit, a small amount of constant high frequency roll-off may be present. In critical applications this may usually be compensated for by partially bypassing the 6SQ7 cathode resistor with a condenser of from .01 to .05 μfd. capacity.

One of the most interesting features of this amplifier is the use of low impedance input circuits. Long used in broadcast equipment, low impedance inputs have several decided advantages over the high impedance circuits found in virtually all conventional public address amplifiers. In the case of crystal microphones, a load impedance of from two to five megohms is usually recommended. As a result, hum pickup is often a problem, due either to loosely braided microphone cable or a fraction of an inch of exposed grid lead. Likewise, in the case of the crystal microphone, the output diminishes as the cable length increases, thereby making adequate, hum free gain a problem where long cables are involved. The high impedance magnetic microphone is usually not quite as critical as regards hum pickup, working satisfactorily into a load resistance of the order of 100,000 ohms. However, high frequency response may suffer severe attenuation where reasonably long cable lengths are used and due to the fact that it is an inductive device, r.f. pickup may represent a problem in some installations. As both types of microphones are of relatively high impedance and the associated circuits are susceptible to unwanted noise pickup, high level mixing and switching is almost a necessity.

The use of low impedance circuits eliminates all of the previously mentioned drawbacks. Microphones may be placed at any distance desired without undue hum or noise pickup, frequency attenuation, or power loss. Circuit switching or mixing may be accomplished at the amplifier input if desired and small amounts of unshielded lead usually do not represent serious sources of hum or noise pickup. High quality input transformers were used in the amplifier design shown and provided input impedances of from 50 to 600 ohms, thereby matching virtually all commercial and broadcast type low impedance microphones as well as being readily adaptable for use with broadcast remote lines.

Nearly all broadcast microphones are of the low impedance variety so that the prospective user should have little difficulty in obtaining as high a quality microphone as desired to go with the amplifier. Likewise, it might be noted that many inexpensive, high impedance, dynamic microphones are actually of low impedance construction, but with a small matching transformer inside the case. If wished, this can be disconnected from the circuit and the microphone used as a straight low impedance unit.

The experimenter should find low impedance input circuits of definite value in work with electromagnetic devices such as pickups and microphones. The use of low impedance circuits means that matching coils can be easily wound with a relatively small number of turns. An example of this is the case of a *G-E* variable reluctance pickup with an open wind-

ing. The old winding was removed and replaced with a few hundred turns of larger wire. Extremely good performance was obtained when the pick-up was connected across the 50 ohm tap of the input transformer and previous problems such as supersonic feedback and high frequency resonance caused by cable capacity were eliminated.

The accompanying photographs show the general parts layout used by the author. Input transformers should be mounted as far away from the output and filament transformers as practical in order to minimize electromagnetic coupling. Electrolytic condensers should be isolated from possible sources of heat for maximum life expectancy although the over-all heat radiation of this amplifier appears to be much lower than that of conventional designs. The entire amplifier was constructed on a 12" by 7" by 3" chassis, however, the resourceful constructor could probably reduce these dimensions through use of smaller, less expensive audio transformers, and miniature tubes.

It should be noted that the close spacing of parts in high gain amplifiers is not necessarily undesirable. Long audio leads should be avoided, if possible, as these provide extra capacity coupling between the chassis and other parts of the audio circuit. As 10,000 c.p.s. is defined as a low radio frequency an appreciable field may exist around the wiring in high level stages and, though the 60 cycle hum pickup of unshielded leads may be very low, difficulties may still be experienced due to supersonic feedback in wide range equipment. A chassis bottom plate is desirable as it tends to reduce the possibility of supersonic pickup from long, unshielded, speaker wires.

Small *Jones* plugs were used for both the input and output sockets, both from the standpoint of flexibility derived from the additional contacts and for the ease in which the circuits may be isolated from the chassis, thus reducing trouble from ground loops. It will be noted that the output transformer used has only 8 and 20 ohm taps. This, however, is sufficient to match one to four 8 ohm speakers and when speaker cables of less than one hundred feet in length are used this does not cause a serious power loss.

The over-all performance of the amplifier built by the author was very satisfactory and it contains a number of features which should be of interest to the high fidelity enthusiast as well as the public address operator. Exceptionally clean response was obtained from high quality tape recordings as well as other input sources although no inverse feedback was used in the amplifier. Maximum sine wave output is 20 watts at 60 cycles, while over-all frequency response is from 30 to 20,000 c.p.s.

A few general comments might be included for the benefit of those inexperienced in public address work. Although a 20 watt system may produce high sound levels in the average living room, it should be realized that apparent loudness is a function of room size and the sound absorption of the walls, furniture, and number of people in the room. Similarly, clearness or intelligibility is a function of the noise level of a given location as well as the frequency characteristics of the acoustics. The result of these factors is that careful speaker placement and high acoustic output are necessary for good coverage under some circumstances. In speaker placement it is usually desirable to use two speakers placed some distance apart and above the heads of the audience if there is any likelihood that part of the group will be standing or sitting in front of them. Similarly, high efficiency loudspeakers are often desirable in order to make the best use of the electrical output of the amplifier. In connection with this, it might be noted that sometimes small diameter loudspeakers, with relatively light cones and magnets, show surprising efficiency. One cluster of four 6 inch speakers produced about twice the output of a heavy-duty 12 inch speaker in comparison tests. Likewise, where intelligibility is of primary importance, low frequency reproduction usually represents wasted power and attenuation below 500 cycles may be desirable.

Often the poor quality of public address sound draws unfavorable comment. Assuming that a good grade of audio equipment is used, the principal problem remaining is that of adequate monitoring. Through use of the long microphone cables, made possible by low impedance circuits, the amplifier and controls may be located back in the audience, making possible accurate adjustments of both volume and tonal balance.

Reliability and consistent performance are of prime importance to the serious public address operator since a single failure can disappoint a relatively large group of people and jeopardize his business reputation. In addition to the inherent advantages of the amplifier described in this article, the relatively small size and light weight should make it practical to take along a spare amplifier for emergency use when covering important events.

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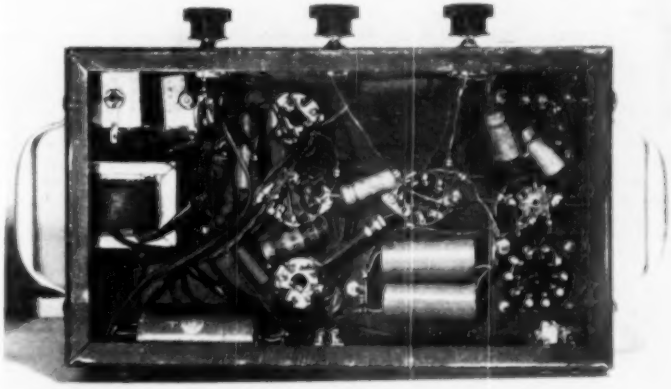
Comparison between the size of a good grade 120 ma. power transformer and the complete voltage tripler power supply used in this p.a. amplifier unit.



Under chassis view of p.a. amplifier showing parts layout and simplicity of wiring.

Fig. 1. Over-all view of the "Mobile Sound Studio."

SOUND ON WHEELS

Not just a p.a. system—it also features wire recorders and a 115-volt power plant for lighting purposes. Much of the equipment may be removed for use on indoor assignments.

By
LAWRENCE J. EPSTEIN
University Loudspeakers, Inc.

A MOBILE sound unit can be either a sideline, serving as a seasonal fill-in source of revenue for the local service technician, broadcast engineer, or ham; or it can be designed, constructed and operated as a genuine, year-round business venture. Often the difference lies only in attention to relatively minor details which increase the efficiency and dependability of the unit and its operation, and the addition or elaboration of services which make the unit truly versatile, flexible, and equal to almost any occasion.

Typical of what might be done along such lines, is the businesslike "Mobile Sound Studio" operated in the White Plains, New York, area by Jack Starr, an old-timer who really learned the hard way. "It's not how loud, but how reliable that counts," says Jack. That principle is apparent throughout the design of the "Studio." The amplifiers and program equipment are standard, commercially available units which may be readily removed from the truck for use on indoor assignments. Auxiliary devices are also made from standard components, adapted in simple fashion to a particular application.

With the possible exception of the collapsible roof-top platform and the loudspeaker stand, which require a small welding machine, all equipment can be constructed and installed using ordinarily available tools.

To start with, a *Marmon-Harrington* Model DVL-4 (Indianapolis) truck was purchased because its features made it especially suitable for such work. Road clearance is only 14", and being a front wheel drive (60 hp. motor), the floor of the truck is completely flat since the customary propeller shaft is eliminated. There are 284 cubic feet of unobstructed loading space, with folding rear, side, and cab partition doors. The front half of the truck (cab) houses operating and control equipment, while the back portion holds the power supply, auxiliary, and emergency equipment as well as stowage. With six forward speeds and two reverse, the truck can creep at speeds suitable for parade participation, or as a mobile reviewing stand.

Power Plant

Perhaps one of the outstanding features of this unit is its complete self-dependence for power, and its ability to adapt itself to a variety of changing situations. Sporting a 3 kva. gas-driven *Onan* Model W3S, a.c. power generator, the unit is capable not only of running a heavy load of electronic equipment, but will furnish spot and flood lamps (see the flood lamps mounted atop pipe on truck radiator, Fig. 1), auxiliary lighting equipment and appliances at remote locations, and has on several occasions furnished hot coffee to shivering politicians on cold November days! In fact, Starr offers his power plant facilities as an emergency lighting service which, more often as not, results in further use of the p.a. facilities for emergency direction. Lawn parties, and grand openings of commercial enterprises are other examples of p.a. work attracted by Starr as a consequence of his power plant capacity and auxiliary lighting equipment.

Fig. 3 is a block diagram of the power plant and associated equipment. The generator is self-starting, operating from the two six-volt storage batteries through the remote control "start-stop" switch located in the cab near the operator. To check the operation of the power plant, a meter panel, located at the rear of the operator (see Fig. 2) includes a 12 volt d.c. voltmeter, oil pressure gauge, d.c. ammeter, battery charge indicator and regulator, and, though not related, an

eight-day clock. A water temperature indicator is mounted alongside the panel.

Power Switch

The a.c. output of the generator is fed through a 30 ampere fuse to a *Cutler-Hammer* Model OO, C83-74 "quick make/break" d.p.d.t. handle-operated drum switch which ties the a.c. load of the unit to either the generator or an outside a.c. source. Whenever available, a line is run to the nearest commercial power outlet and fed to this selector switch through the lock-twist connector on the roof-top and through a 30 ampere fuse. Fuses used are the *Fusetron* delayed action type, so that momentary surge voltages will not interrupt service. The switch may be seen in Fig. 2 at the left side of the instrument panel. Instant switchover is thus made possible should the commercial power at the source tapped fail because of excessive load. All a.c. lines are polarized and each outlet marked for "grounded" side. When an external power source is used, the grounded side is determined by the simple light bulb method (with one side to earth, the outlet is probed for the "hot" side which will cause the light to glow). This assures consistency in grounding of electronic equipment and reduction of static charges which otherwise have a tendency to build up, causing shocks and hum.

Distribution of Load

A number of a.c. outlets and some ceiling lights are then directly fed from the power switch. Across the output are an a.c. voltmeter and ammeter. These serve to check loading condition, should a limit be necessary as a consequence of using an external power source, or to check the load on the generator.

Some devices are fairly critical when it comes to a.c. operating voltage, while others (such as turntables and recorders) require fairly accurate and stable frequency. For these reasons the line which feeds the amplifiers, turntables, and recorders first goes through a heavy duty *Variac* unit, with an output voltage indicating meter. A *J.B.T.* frequency meter is used to check the line, and should power be coming from the generator unit, the frequency can be adjusted for a given load by a knob control which governs the driver engine r.p.m.

Muffling Generator Noise

Since announcements, as well as recordings, are often made in the spacious cab, it was necessary to soundproof the cab and as much of the truck as possible. The easiest way to do this was by enclosing the generator in a compartment lined with ¾" *Celotex* and finished with pressed board. The rear of the generator may be seen in Fig. 2, a section of the enclosure having been removed. This muffled the engine noise considerably but presented a further problem in keeping the generator from overheating on hot days or in close quarters. A louvered air vent was installed facing the rear left wheel. A 1/10 hp. electric motor with an 18" bucket blade was then installed at the front of the enclosure, this motor deriving its power from the generator output. At least a 10° decrease in water temperature results from this forced air draft, which is then sucked in by the generator's own intake fan and the air pushed forward through the driver engine radiator and out the louvered air vent at the rear of the enclosure. This auxiliary cooling fan is turned on from the operator's position in the cab.

Should additional cooling become necessary, there is an auxiliary water-circulating centrifugal pump, driven by a 1/6 hp. electric motor, also deriving its power from the generator output, which is turned on from the cab. The gas engine uses a thermo-syphon water cooling system which depends upon water temperature for circulation. The pump produces circulation before permitting the water to reach the critical temperature, thus maintaining a low average water temperature. Although it would seem that engine efficiency should suffer, in practice these auxiliary devices have enabled the power plant to continue uninterrupted service for long periods of time under very trying conditions. As for fuel supply, the power plant itself holds five gallons of regular gaso-

Wire Size B & S	SPEAKER TRANSMISSION LINE IMPEDANCE					
	4 Ohms	8 Ohms	16 Ohms	100 Ohms	250 Ohms	500 Ohms
14	125'	250'	450'	1000'	2500'	5000'
16	75'	150'	300'	750'	1500'	3000'
18	50'	100'	200'	400'	1000'	2000'
20	25'	50'	100'	250'	750'	1500'
% Power Loss	15%			5%		

Table 1. Chart showing the maximum practical speaker line lengths for sound installations.

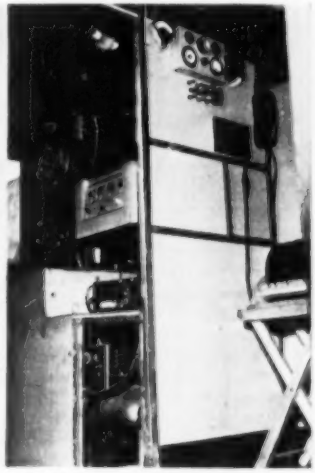


Fig. 2. Meter panel for checking operation of the truck's power plant. The panel includes a 12 volt d.c. voltmeter, oil pressure gauge, d.c. ammeter, battery charge indicator and regulator, and an 8-day clock.

Fig. 3. Block diagram of a typical power plant and its associated auxiliary equipment.

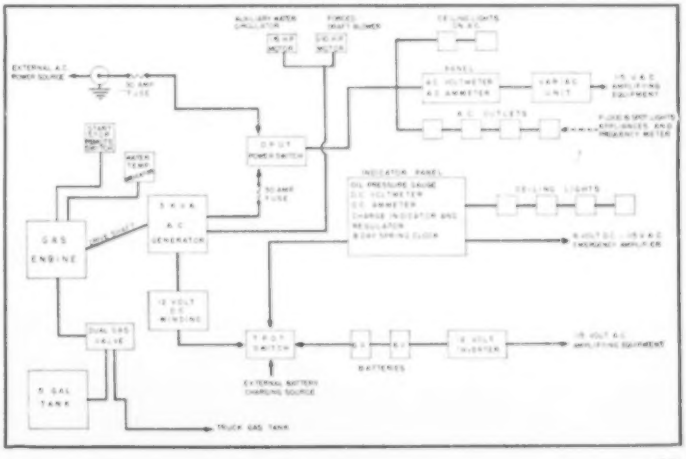
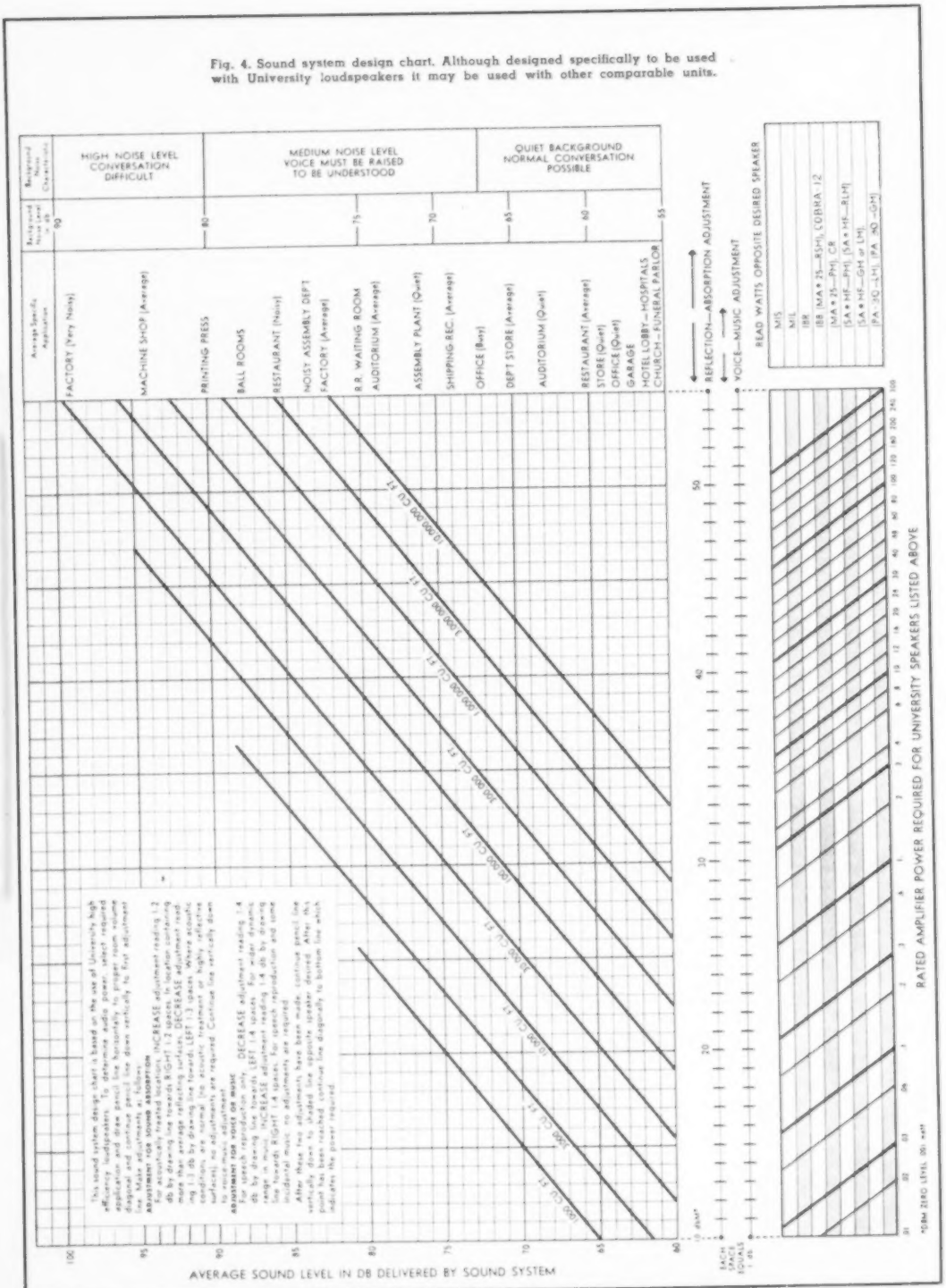


Fig. 4. Sound system design chart. Although designed specifically to be used with University loudspeakers it may be used with other comparable units.



This sound system design chart is based on the use of University high efficiency loudspeakers. To determine audio power, select required application and draw pencil line horizontally to proper room volume diagonal and continue pencil line down vertically to first adjustment application where sound ABSORPTION

For acoustically treated locations, INCREASE adjustment reading 1-2 db by drawing line towards RIGHT 1-2 spaces. In location containing more than average reflecting surfaces, DECREASE adjustment reading 1-1 db by drawing line towards LEFT 1-3 spaces. Where acoustic conditions are normal, the acoustic treatment may be omitted, no adjustment or correction is required. Continue line vertically down to second adjustment

ADJUSTMENT FOR VOICE OR MUSIC

For speech reproduction only, DECREASE adjustment reading 1-4 db by drawing line towards LEFT 1-4 spaces. For wider dynamic range in music reproduction, INCREASE adjustment reading 1-4 db by drawing line towards RIGHT 1-4 spaces. Where high fidelity and some low level reproduction and some loudness effects are required

After these two adjustments have been made, continue pencil line vertically down to shaded line opposite speaker desired. After this point has been reached continue line diagonally to bottom line which indicates the power required.

line, enough for eight hours' operation at full load capacity. However, a dual valve is installed at the cab so that the operator can feed gas from the truck's tank to the generator, if need be!

Emergency Source

A twelve volt *ATR* inverter is also ready to swing into action should both a.c. power sources fail. The inverter is run off the same two 6-volt batteries which are used to start the generator engine. When the engine operates, it automatically charges these batteries from a secondary winding on the generator which delivers 12 volts. A t.p.d.t. knife switch (Fig. 2, just below the meter panel) provides various arrangements whereby the batteries may be charged from the generator or an outside source, used to start up the generator, or six volts tapped for direct operation of a 30 watt emergency amplifier, just in case the two a.c. power sources *and* the 12 volt inverter fail!

Loudspeakers

Fig. 1 shows a full view of the unit, with four *University* LH trumpets and SAHF driver units mounted at the corners, and *University* Cobra-12 wide angle speakers covering the mid-sections. When used with large trumpets the new Cobra-12 adds to the crispness and penetrating qualities of the over-all reproduction, as well as to fill in voids. As shown in the photograph, operation is set at 360° coverage. 180° coverage, at full strength, is accomplished by simply directing the two front LH trumpets straight forward and turning the two rear trumpets to face fore and aft, favoring the working side by about 15°.

The trumpets are mounted to the roof-top by a single bolt through the center hole of the "U" bracket, thus permitting simple adjustment of the trumpet direction. Vertical adjustment of the trumpets and Cobra-12 are, of course, also possible, so that the "throw" may be fixed as required. Vertical adjustment should be made to suit the size of the audience (working area) anticipated, directing the speaker axis to a point approximately $^2/_3$ the distance to be covered. Lines are brought into the cab by means of *Amphenol* feedthrough connectors, directly alongside the speakers.

Fig. 5 is a close-up of the loudspeaker stand. Again *University* Model LH trumpets are used, but this time with the Model PA-30 driver unit. There are 10 such stands, some accommodating three of the smaller PH trumpets and some for a single $6^1/_2$ ft. air column GH trumpet. They are employed to cover vast areas which are too distant to be covered by the truck speakers alone. Due to losses which will be experienced with such long lines, the *University* PA-30 is used because the built-in multi-impedance line matching transformer facilitates operation of the transmission line at high impedances, to minimize the loss for a given size wire. The chart of Table 1 indicates maximum transmission line lengths for various size wires and commonly required impedances.

Naturally, as the number of remote speakers used varies, the impedance selected at the driver varies, in order to maintain a proper match at the amplifier. Such change is readily accomplished at the base of the PA-30 driver unit which has an exposed weatherproofed terminal block, thus avoiding the need to make any internal driver connection changes.

However, in the case of the rooftop loudspeakers, the 16 ohm voice coil lines of the SAHF driver units and the 8 ohm lines of the Cobra-12 speakers are brought into junction boxes which contain a *University* #5408 multi-tap line matching transformer and selector switch. In addition to an "off" position, available impedances are 500, 1000, 1500, and 2000 ohms. Thus, if only the three speakers on one side of the truck are to be used, along with two LH/PA-30 loudspeakers at a remote location, and assuming that it is desired that the amplifier power be split evenly between the truck and the remote speakers, the following connections would be used:

(1) Speakers 1, 2, and 3 switched on, in the 1500 ohm positions. This equals 500 ohms. Speakers 4, 5, and 6 switched to "off."

2. The 1000 ohm terminals of the two PA-30 driver units paralleled and the resultant 500 ohm line run to the truck.

3. These two lines then are paralleled, resulting in 250 ohms which is then connected through the amplifier changeover switch to the 250 ohm output of the amplifier.

Any number of properly matched combinations are thus possible with a loudspeaker arrangement as provided by the equipment used by the "Studio."

As protection against lightning, the lines from the remote loudspeakers, when used, go first to a lightning arrester before entering the truck. When external a.c. is used, the truck serves as ground, through the grounded side of the a.c. When the power plant is

Fig. 5. Closeup of loudspeaker stand.

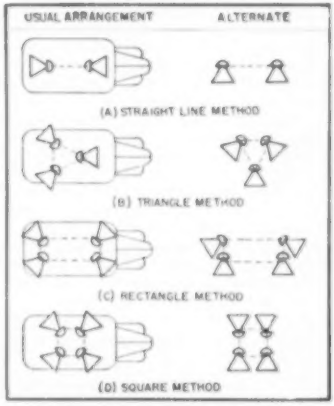


Fig. 6. Several common methods of positioning loudspeakers on the mobile sound unit.

Fig. 7. Block diagram of the instantaneous switching panel and associated equipment.

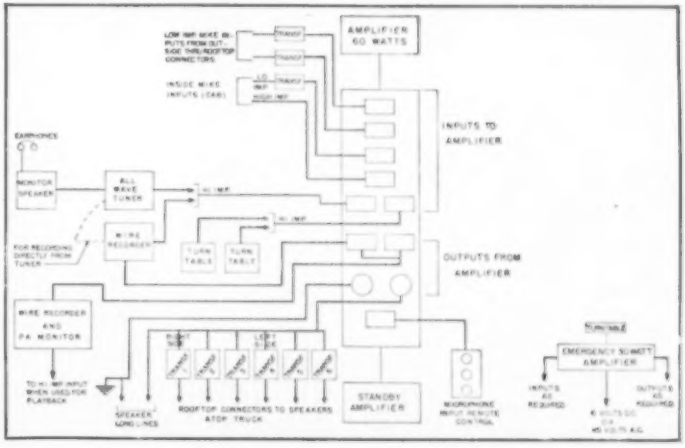


Fig. 8. University Loudspeaker, Inc.'s Model RLH radial reflex loudspeaker unit.

used, a ground stake is driven into earth or a line run to any nearby grounded metallic object.

Fig. 6 illustrates several common methods of positioning loudspeakers on mobile units. They provide a degree of necessary flexibility and may be used for most soundcasting applications. Naturally, the more speakers used to cover a given area, the higher will be the sound pressure at any one point. For example, alternate method "C" will certainly produce more sound for a 180° angle of dispersion than will alternate method "B." "B," of course, is obviously superior to "A."

Method "D" for 360° coverage is better than "C" because a more uniformly distributed sound pressure will result, but "C" will do a better job when only 180° coverage is required.

Method "B" is obviously a compromise between the two- and four-speaker systems. It will perform well for both 360° and 180° requirements.

More elaborate speaker layouts than illustrated are sometimes used, but more often than not they are designed to increase distance covering ability and to cope with special vertical propagation problems. Dispersion angle and low frequency cut-off ratings of projectors are an important factor in deciding which system should be used. These ratings are directly related to the length, flare, and mouth diameter of the projector. Contrary to what one might normally expect, the shorter, smaller trumpets have a wider dispersion angle than the larger projectors. Low frequency cut-off, a function of air column length and hence horn size, is of course lower for the larger projectors than for the small ones. Thus, there evolves a paradoxical situation where we must tolerate narrow dispersion angles for large projectors in order to obtain greater fidelity, while dispersion from the smaller trumpets, which have limited low frequency response, is relatively wide.

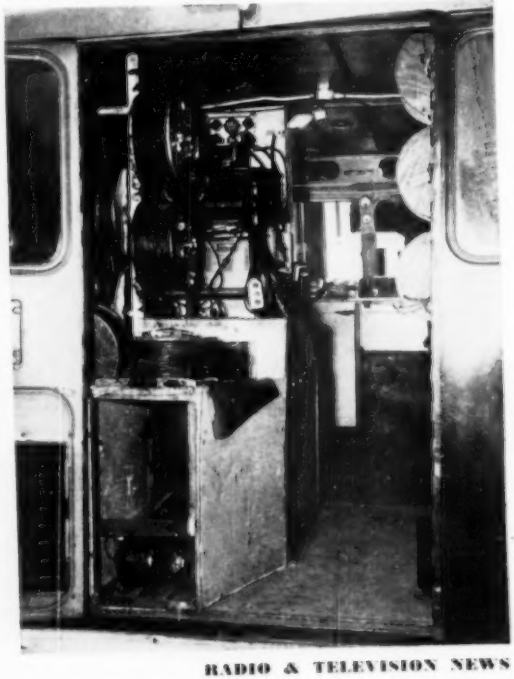
Re-examining the layout methods of Fig. 6, one can readily appreciate that to do a really good job, the four-speaker systems should be employed where the larger 4½' and 6½' reflex trumpets are required, the three-speaker method used for 3½' or 4½' reflex trumpets, and the two-speaker arrangement reserved for 2½'-3½' projectors. Where cost is of prime importance, or a relatively small area is to be serviced, the larger trumpets can be used; or a radial reflex projector, such as the *University* RLH, can be suspended atop the vehicle to give uniform 360° propagation. When used with a Model 2YC adapter and two SAHF or PA-30 driver units, this single speaker will handle 50/60 watts of power with excellent fidelity. Sound pressure at any one point will be lower, however, than when a multiple speaker layout is used. Fig. 8 is an illustration of such type projector.

"How much power do I need?" is perhaps the most often heard question in this business. Much has been written regarding the subject, with the answer invariably being, "It all depends!" This goes without saying, but most successful sound trucks have been able to do a decent job with a good 60 watt amplifier and some top-notch loudspeakers. Merely as a guide, Fig. 4 is a chart which may be used for any type indoor or outdoor sound installation. Generally speaking, the sound pressure at any one point in an area covered, should not be less than 6 db. over the level of ambient noise reaching the same point. A leeway of 10-15 db. is preferable. The nature of the interfering noise will determine the level difference necessary. Adjustment of the frequency response of the system, using the amplifier tone controls, can be quite effective. Noise containing a heavy amount of the audio spectrum reproduced in the pro-

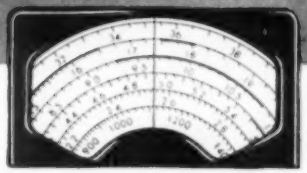
(*Continued on page* 190)

Fig. 9. The amplifiers used in the mobile "studio" operate on 115 volts a.c. and are placed at right of the truck operator.

Fig. 10. View of the rear of the truck. Reels hold microphone, loudspeaker, and the power line cables for easy accessibility.



International SHORT-WAVE



Compiled by **KENNETH R. BOORD**

THIS month we are pleased to present some interesting data on reception from Europe as passed along by Edward E. Goodman, Fredericksburg, Virginia. Over the past ten years, Mr. Goodman has kept an informal record of reception from Europe, from which he has compiled this data showing what wave bands are best in his area at different seasons of the year and at various times during the day. His listening post is 50 miles south of Washington, D. C., 50 miles north of Richmond, Virginia, and is located on the Rappahannock River.

The data—by bands—follows:

Summer (May, June, July)—11-m., 0500, 1430; 13-m., 0400, 1600; 16-m., 0230, 1730; 19-m., 0100, 0530, 1430, 1900; 25-m., 2330, 0400, 1600, 2030; 31-m., 1730, 0230; 41-m., 1900, 0100; 49-m., 2080, 2330.

Autumn (August, September, October) and *Spring* (February, March, April)—11-m., 0700, 1300; 13-m., 0530, 1430; 16-m., 0400, 1600; 19-m., 0230, 0700, 1300, 1730; 25-m., 0100, 0530, 1430, 1900; 31-m., 2330, 0400, 1600, 2030; 41-m., 1730, 0230; 49-m., 1900, 0100; 60-m., 2030, 2330.

Winter (November, December, January)—11-m., 0830, 1130; 13-m., 0700, 1300; 16-m., 0530, 1430; 19-m., 0400, 0830, 1130, 1600; 25-m., 0230, 0700, 1300, 1730; 31-m., 0100, 0530, 1430, 1900; 41-m., 1600, 0400; 49-m., 1730, 0230; 60-m., 1900, 0100.

* * *

Club Notes

England—A *new* club with radio departments is *The International Friendship League*, 5, Aldred Street, Worksop, Notts., England, founded by Eric Good and Miss Maureen Martin; welcomes overseas members; has monthly bulletin.

USA—*New* QRA for the *Universal Radio DX Club* is 29201 Dixon Street, Hayward, California. This club should have a new s.w. log out this month or next; *is for members only.* (Winch, Calif.)

* * *

This Month's Schedules

(NOTE: By the time you read this, some stations will have reverted from Summer Time to Standard Time; in such cases, you may find schedules *one hour later* than listed herein.—KRB)

Anglo-Egyptian Sudan—Radio Omdurman, 9.745, is again being heard at good strength daily 2315-2345. (Fargo, Ga., Bellington, N. Y.)

Argentina—LRS2, 11.971, Buenos Aires, noted underneath *Radio Brazzaville* with weak signal 1949. (Cox, Delaware)

Australia—At the time this was compiled, *Radio Australia* had just replaced VLC7, 11.81, with VLC4, 15.32, for the morning program to North America 0700-1015; however, reception over the 15.32 outlet was so poor that it is likely a further change will have been effected by this time—probably back to 11.81 and possibly with the old 9.54 channel added. Sydney, 6.090, is coming through well here in West Virginia 0600 with ABC news.

Austria—The Blue Danube Network, 9.617, Salzburg, is scheduled 0000-1800 (Sundays from 0100). (ISWC, London) In verifying for Bellington, N. Y., listed news times as 0030, 0115, 0400, 0600 (followed at 0610 by local news), 0800, 1000, 1215, 1655, 1755. Station officials inform me "we verify here by QSL one hundred per-cent and *do appreciate the receipt of an IRC with the reception report.*" QRA is Station Manager, BDN Salzburg, APO 541, c/o P.M., New York, New York, USA. All transmissions are in *English*.

Bechuanaland—Mafeking, 8.242, is scheduled 0600-0700, 1200-1430. (Radio Sweden)

Belgian Congo—OTC, 9.767, 50 kw., Leopoldville, has effected *new* schedules and by this time may be using 9.800 instead of 9.787 in the Second Transmission, due to QRM on the 9.767 channel during transmissions to the Americas. Schedules are—*First Transmission* — 1100-1245, French, Dutch, program for Belgian missionaries and Belgian seamen and Belgium calling her countrymen in the world; 1245-1300, closedown for change of beams; 1300-1400, Dutch, Belgium calling the Netherlands and South Africa; 1400-1500, *English*, Belgium calling Great Britain and the British Territories in Africa; 1500-1615, French, Belgium calling France, Switzerland, and the French Union; 1615-1815, Dutch and French, program for Belgian seaman and their French and Dutch friends; 1815-1830, closedown for change of beams.

Second Transmission — 1830-2000, *new* Portuguese and Spanish period, Belgium calling South America; 2000-2030, Dutch and French, Belgium calling her countrymen in the world; 2030-0015, French and *English*, Belgium calling Canada and the United States; 0015-0100, French and Dutch, Belgium calling Belgian missionaries in the world; 0100, closedown. Each Monday at 1315-1815 and each Sunday 2030-0015 there is a non-stop musical program (listeners' requests on Monday from 1400); each Wednesday, the *English* programs are devoted to DX-ers and radio amateurs, giving s.w. data and radio club information; every alternating Friday at 1410 there is a special "Amongst Friends" Edition in Swedish in answer to letters from Swedish listeners; a preview of the coming week's musical programs is radiated each Sunday at 1410 for Britain and is repeated 2210 for North America.

Contrary to reports from outside the

(*Continued on page* 150)

(Note: Unless otherwise indicated, all time is expressed in American EST. add 5 hours for GCT. "News" refers to newscasts in the English language. In order to avoid confusion, the 24-hour clock has been used in designating the times of broadcasts. The hours from midnight until noon are shown as 0000 to 1200 while from 1 P.M. to midnight are shown as 1300 to 2400.)
The symbol "V" following a listed frequency indicates "varying." The station may operate either above or below the frequency given.

William N. Parker, Raleigh, N. C., likes his new NC-173. He has been a DX-er since '35.

G. Cox, Del., has built up a good log in a hurry, including some fine Far East "catches."

Selecting Your HIGH-FIDELITY SYSTEM

Test console in center permits any of units shown to be "comparison" tested.

By JAMES F. BECKER
Consulting Eng., Concord Radio Corp.

A description of the basic units for a home sound installation and what to look for when buying them.

DUE to an ever increasing desire for "better listening" on the part of the public, the demand for high-fidelity equipment has shown a very pronounced upswing in recent years. This "sound consciousness" has been an instrumental factor in the development by radio and sound equipment houses of what is now known as the "Hi-Fi Package," a combination of individual units which provides the average music lover with a nearly true reproduction of his or her favorite music, a reproduction heretofore attained only by those few individuals who could spend substantial sums of money for such quality. It is now possible, because of new and improved design on the part of the manufacturers, for a person of moderate means to spend many enjoyable hours listening to high-fidelity reproduction at a reasonable cost.

All of this leads the music listener to ask: What is high-fidelity and how do I go about selecting the units which comprise such a system? How can I choose a "Hi-Fi Package" which will best meet my requirements? What assurance have I that the equipment I choose is the finest available for the amount of money spent? It is the purpose of this article to set forth the major considerations involved in the selection of a "Hi-Fi Package" and thereby enable you as the average listener to get the most for your money.

"High-Fidelity" Defined

What is high-fidelity? Strangely enough, the sound engineers have not as yet been able to make any clear-cut definition of this term. However, it is generally conceded that there are certain basic characteristics which must be present if true high-fidelity reproduction is to be obtained.

The first of these characteristics is frequency response or the ability of the system to faithfully reproduce all sounds in the musical register from the lowest note on the bass viol to the highest overtone of the piccolo within the audible range. Although this range may vary among individuals, the generally accepted average limits for true reproduction are 30 cycles-per-second for the low frequency end and 15,000 cycles-per-second for the high frequency end.

In addition to wide frequency response, the high-fidelity system (or package) must not only be able to reproduce sounds in the 30 to 15,000 cycle range but reproduce them uniformly. This means that each unit in the system must be capable of reproducing the low tones in the frequency range to the same degree that it is capable of reproducing the high tones. A system uniformly covering the above range would be considered "flat from 30 to 15,000 cycles."

However, adequate frequency response and uniformity are not enough in themselves. In order for a system to provide true reproduction, it must be free of all extraneous noises that would tend to mar the audible output. This means that it must have a "low distortion" characteristic. In technical terms, an over-all distortion level of three per-cent is considered acceptable.

Taken by and large, a sound reproducing system may be considered to be "high-fidelity" in the layman's language if it imparts life and tonal quality to the sounds being reproduced. Compared to a true high-fidelity system, the ordinary radio console or phonograph reproduction will seem lifeless and without color. The effect of the high-fidelity system is to "remove" the listener from his surroundings and transport him to the performance hall. The listener, upon hearing such a system for the first time, will be quite astounded by the amazing increase in clarity and the addition of sounds (previously inaudible) which will become apparent.

High-Fidelity Components

What are the units which comprise a Hi-Fi system and what are the basic considerations in the selection of each of these? Generally speaking, there are five basic components to a high-fidelity system:

(1). A radio tuner (FM, AM, or both).
(2). An automatic phonograph turntable.
(3). An amplifier.
(4). A speaker.
(5). A speaker enclosure which houses the speaker and provides it with the proper baffle and air space.

You, as the buyer, will want to know which of these units is the most important. To which should you devote the greatest share of your attention and financial resources? There are almost as many opinions on this matter as there are types of equipment in use. Actually, each component is the most important one. The units are completely integrated and the over-all performance of the system is determined solely by the performance of the "weakest" individual unit. The quality of the system becomes the quality of the poorest component.

The selection of a fine tuner is entirely superfluous if it is not backed up by a fine amplifier and speaker. Similarly, the performance and ability of an amplifier to reproduce frequencies from 30 to 15,000 cycles means absolutely nothing if a speaker which can only reproduce from 100 to 8,000 cycles is attached to the output.

The speaker enclosure itself can impair the excellent reproduction quali-

ties of a first rate speaker if it is not properly designed to mount the unit in use.

The basic principle to keep in mind then is this: If one component is of inferior quality, the operation of the entire system will be reduced to that level. For this reason then, it is wise to determine first of all how much money you have available to spend and secondly, the proportionate amount you can afford to spend on each unit in order to obtain the same required degree of performance from each.

Home Requirements

Before going into the considerations involved in the selection of each unit, a brief review of the over-all home requirements of a high-fidelity system is in order.

A certain amount of thought should be given to the physical size of the room in which the system will operate. Certainly a small room such as a den will not require the power-handling capabilities of an amplifier designed to operate in a large living room; by the same token, the actual space area available for the installation of the system is apt to be considerably reduced in the smaller room. Therefore, before starting out to select your units, it would be a good idea to have some of these physical requirements in mind.

It would be an excellent idea for you as a prospective buyer to carry with you a mind's eye view of the proposed installation, or better yet, a small sketch of your ideas as you start shopping for your high-fidelity components. Not only will this serve as a reminder to you, but it will also materially aid the sales technician with whom you talk, in that he can better determine the type of system which will best suit your needs.

Individual Components

You are now ready to proceed with the main job of selecting your system, component by component. The considerations offered here are not to be thought of as all-inclusive inasmuch as there are many minor items which will depend largely upon the individual's personal likes and dislikes. These are the major considerations which will affect the over-all operation of the system.

Tuner

The tuner section of the high-fidelity system is the unit which makes possible the reproduction of programs from the radio broadcast field. It may be designed to receive the amplitude-modulated portion of the radio spectrum, or the frequency-modulated portion, or both. Generally speaking, the amplitude-modulated or AM tuner receives little consideration in a high-fidelity system due to the fact that the reproduction of audio frequencies on AM is limited, on the average, to approximately 5000 cycles. If you are limited by financial considerations to the use of a frequency-modulated or FM tuner and are primarily a music listener, the inability of your tuner to handle AM will mean very little since most musical programs are broadcast simultaneously on FM. (The upper limit of reproduction for FM broadcasting is 15,000 cycles or three times that obtainable on AM.)

In general, the average tuner has been designed to operate on both FM and AM. The ease or ability with which a tuner will receive either type of signal from a distance is known as its sensitivity, and its ability to differentiate between stations is known as selectivity. For those individuals located in metropolitan areas, the sensitivity of the tuner is not too important since most FM stations are located well within the "fringe area." However, for those listeners located beyond the 35-mile point ("fringe area"), sensitivity becomes a prime consideration. First then, select a tuner which will provide adequate FM reception in your locality. Secondly, choose a tuner which will provide adequate selectivity. If you are located in a congested area where several stations are operating near the same frequency, be sure your tuner will easily differentiate between these stations.

Because of the high frequencies on which they operate, many FM tuners tend to "drift" from their initial dial settings thus requiring frequent retuning. Therefore, the third consideration becomes that of choosing a stable tuner. A few of the high priced tuners have an automatic frequency control feature which tends to minimize drift. This is of course a desirable feature. However, the average tuner usually becomes stable once normal operating temperature has been reached.

The fourth major requirement is that of frequency response. Here again, the purse becomes a determining factor since the broader the response the higher the cost. A good tuner, however, should have the ability to reproduce uniformly the audible frequency range from 30 to 15,000 cycles. Furthermore, hum and distortion levels should be inaudible, and separate bass and treble controls should be provided on the tuner if they are not incorporated in the amplifier.

The appearance of the unit is also important, but this is a matter of individual taste since some will like one design while others prefer another. The physical size can become a major consideration when space is at a premium. This is particularly true where the tuner is to be utilized as a replacement for an existing unit already mounted in a special cabinet.

Phonograph

Selection of a phonograph for the high-fidelity system involves many considerations, both electrical and mechanical. Here again, adequate frequency response is a major factor. Most present day recordings have a top frequency range of 10,000 cycles. The advent of improved recording disc materials and methods has further boosted this range so that special high-fidelity records with a frequency response from 30 to 14,000 cycles are now available. If you plan to buy recordings in this bracket, a phonograph with cartridges designed to reproduce these frequencies should become a part of your system.

The type of head in the pickup arm, whether of the crystal or magnetic cartridge variety, also plays an important part in the selection of the proper phonograph for your need. The output from a crystal cartridge is considerably more than that which can be obtained from the magnetic types, but the frequency response, in most cases, is limited. Some crystal cartridges, recently developed, offer smooth, wide-range response for the new high-fidelity recordings.

The advent of long-playing microgroove records, designed to operate at speeds of 33⅓ and 45 revolutions-per-minute, has created a demand for three-speed changers and triple-play or interchangeable heads. As a general rule, today's buyer will almost always purchase a three-speed changer. Two-speed and single-speed changers are rapidly becoming obsolete. The main factor to be considered is the purchase of a changer which will provide the desired degree of reproduction at all three speeds and still stay within the range of one's purse.

Needle arrangements are provided with the better pickup cartridges and their affect on the operation of the head is taken into consideration in the

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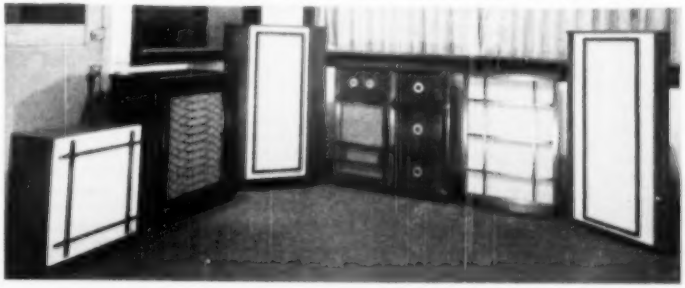
A section of the sound room at Concord Radio Corporation's Chicago showrooms. Here a prospective buyer may try out a wide variety of high-fidelity audio components.



Mac's RADIO SERVICE SHOP

By JOHN T. FRYE

A SOUND SIDELINE

THE crisp, starry November night was filled with the pungent autumn incense of burning leaves as Barney, whistling softly, strode along the empty street on his way home from a picture show. As he passed the radio shop where he worked, the whistle suddenly broke off in the middle of a bar. Something was wrong! He could not see the night light over the service bench that ordinarily was clearly visible through the deliberately left-open door of the service department.

Flattening his freckled nose against the shop window and cupping his hands around his eyes, the youth saw that the service door was closed; furthermore, judging by the ribbon of white light escaping through a crack at the bottom of the door, someone had the main fluorescent lights of the service department turned on.

Wheeling around, Barney shot a quick glance at the cars standing at the curb; then, as he recognized Mac's trim little sedan, the cops-and-robbers melodrama that had already started to flare in his imagination—with you-know-who as the hero—began to fade. Fishing his store key from his pocket, the boy softly opened the door and stepped inside.

Instantly his ears were assailed by a mournful and rather faltering rendition of "Home Sweet Home" being played on a harmonica. He tiptoed across to the service-room door and opened it a crack. A strange sight met his eyes. Mac, his eyes tightly closed, was breathing the melody into a microphone that was set so close in front of him that the backs of his hands, with which he was doing a very professional job of "tremoloing," almost brushed it. The floor at his feet was littered with crating boards and packing paper. On the bench in front of him, its plastic reels gleaming as they whirled about, was a brand-new and very resplendent tape recorder.

"Holding out on me, huh" Barney shouted as he banged the door wide open and stepped inside.

Mac's head jerked back beneath his shoulders like a turtle's, and he nearly swallowed his musical instrument at this rude and unexpected interruption of his recital.

"I might have known!" he complained bitterly as he recognized the intruder. "I was going to surprise you with this in the morning, but keeping a secret from a nosey Irishman like you is harder than keeping the medicinal whiskey hidden from Grandpa."

"Never mind that; why the midnight solo?"

"I was just trying out this new tape job. A French-harp is the only instrument that I know well enough to know how it *should* sound. Listen."

He flipped the rewind switches and, after a few seconds of rapid rewinding, started the tape through again. Out of the speaker came the sound of the harmonica with such startling naturalness, even to the breath sounds, that it was hard to realize it *was* a recording.

"Some gadget, eh?" Mac questioned proudly. "It ought to be; it cost enough. Notice that tape is pulled at a steady fifteen inches per second *all* the time and *every* time. That accounts, in part, for those highs. Get a load of how it catches this cymbal." With this he switched the recorder to "Record" and whanged an old brass cymbal with a screwdriver handle. When it was played back, the brassy sound echoed through the shop exactly the same as it had done before.

"Yes, but what are you going to do with it?" Barney asked.

"Sell records."

"Ha! It sounded just like you said, 'Sell records.'"

"That's what I *did* say. This tape recorder is going to be used to boost our disc recording business, which has never been too robust. My idea is that I shall take down anything I intend to put on disc on this tape-recorder first. That will give me a chance to get a perfect recording before I start cutting a platter. Any needed editing can be done on the tape. If a mistake bobs up, we can simply erase the tape and start over. That will mean a substantial saving in spoiled blanks, and it will allow the customer to be recorded at his best.

"But even better, it will allow me to do 'free-lance' recording. By that I mean that I can take this tape job to high school entertainments, amateur shows, and so on and take down various events that I think some of the performers may be willing to purchase in disc form. Then I can invite those people down to listen to themselves—a hard invitation to resist—and then if they want a permanent disc recording of their performance we can make it for them. If they don't, all we are out is our time."

"Hey, that sounds all right!" Barney said. "You can take programs off the local radio station, too, especially those street-interview sort of things. Lots of people would like to have a record of their voices on a radio station. Since next year is the Year of the Big Wind, election year, you ought to get lots of business from political candidates. Instead of quoting what his honorable opponent said, the rival candidate can actually play a recording of the quotation, which will be a lot more effective."

"And then," Mac chimed in, "there are many special events, such as weddings and so forth, that people would like to have preserved—at least in part. We can take the whole thing down on tape and then let the customers select the portions they want on disc."

"Sounds to me like Mac's Radio Service Shop is going to put a heavier accent on the sideline."

"On several sidelines," Mac corrected. "I have been thinking that we are kind of in a rut just working on radio and TV about ninety-five percent of the time and are letting a lot of good money-making business slip away from us. This is particularly true in the sound field. From now on we are going out aggressively after the sale, rental, service, and installation of all kinds of sound equipment."

"I thought we were doing reasonably well in the rental and service fields," Barney offered.

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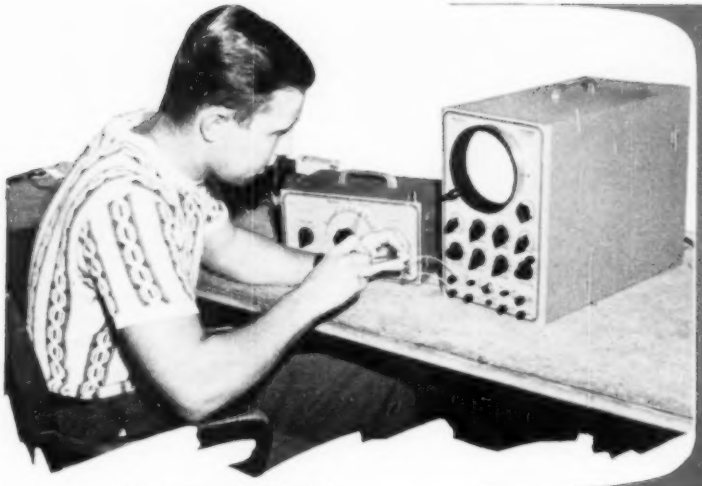


Let's Put SQUARE WAVES To Work

Using compensating circuit to observe square wave patterns.

By
HOWARD ANTHONY
The Heath Company

A discussion of the applications of square wave testing techniques for checking audio amplifiers.

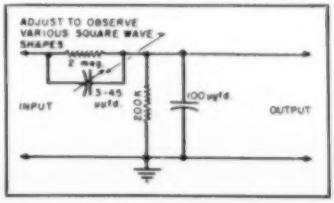
NUMEROUS articles have appeared recently about the theory of square waves but in the busy world of television most of us do not have the time to interpret and apply these theories. Television, however, with its FM sound, makes the applications of square wave testing particularly important. This article deals with a few of the many possible applications.

Once understood, the user will find that square waves simplify and speed audio servicing. One square wave test is the equivalent of ten or more sine wave measurements plotted on a graph. Square wave tests at two points are usually sufficient to establish the response characteristics of the average audio system. One large television manufacturer uses two square wave test frequencies as the only fidelity check on the sound portion of the TV receivers. This saving of testing time is extremely important when thousands of units must be tested. The time in this case is held to a few seconds per unit. The system has been found to be extremely satisfactory. The same technique applied to service work can result in a remarkable saving of service time and better customer satisfaction.

The easiest way to understand the various square wave shapes obtainable is to actually obtain a variety of shapes by use of simple adjustable compensating circuits. By means of these, it is possible to see for yourself the effect of both high and low frequency attenuation or emphasis. Fig. 1 shows such a circuit. The practical start is to build this network and observe its effects. More understanding can be gained this way than in studying hundreds of traces. A square wave may be considered a graph of the performance of the instrument under test at the fundamental and to the thirtieth harmonic of the frequency being used. Thus if the gain of the higher frequencies is more than the fundamental, the square wave will tilt upward while if the higher frequencies are attenuated, the square wave will round off at its forward edge. Using the circuit shown in Fig. 1, it is possible to emphasize or attenuate the higher harmonics and see this effect.

For further understanding and classroom demonstration, a single amplifier stage with variable controls used for each resistive element will show the many possible effects. Where an amplifier is to be used for a special purpose, the use of a square wave of desired frequency and variable elements will often enable the experimenter to secure several times the normal gain obtained when the standard tube loadings as shown on the tube charts are used.

Fig. 1. Frequency compensating circuit for use in observing square wave shapes.



A suggested procedure for obtaining optimum amplification is as follows. Use a low frequency square wave of 100 cycles. Try several sizes of coupling condensers and establish the minimum size which does not affect the square wave. Replace the cathode resistor with a suitable variable control. A 10,000 ohm control is usually adequate. Replace the plate resistor and screen resistor with variable controls providing ample range of resistance. Initially set each control to the approximate resistance replaced. Adjust each control to obtain the maximum size of square wave without distorting the shape. As there will be interaction between the control settings, the plate and screen controls must be adjusted for each change of the cathode control. After the optimum settings are obtained, the resistance of each control should be noted. This will assure best performance of the amplifier between 100 and 3000 cycles. The entire procedure should then be repeated with the square wave generator set at 1000 cycles giving an indication of the amplifier's performance to well above 20,000 cycles. If there is an appreciable difference between the resistances of the two tests, a compromise can be effected. The variable controls are then replaced by resistors of proper value. The writer has often obtained gains of one and one-half to twice the normal gain of amplifier stages by this method.

In normal service testing of amplifiers, the square wave is fed through the entire instrument. If distortion is found to exist, the oscilloscope connec-

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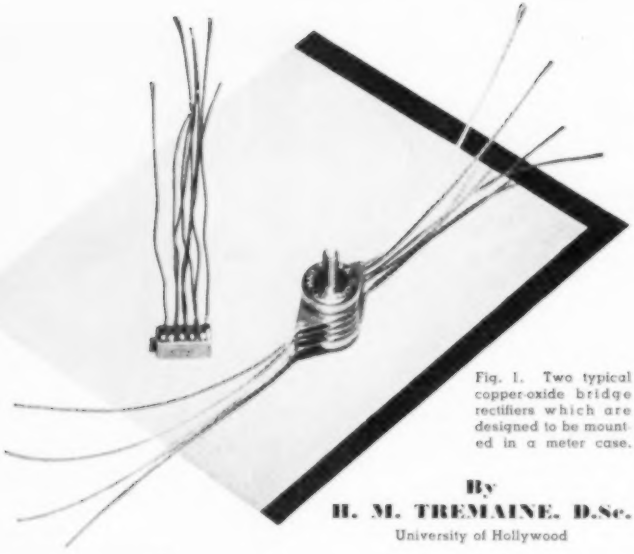


Fig. 1. Two typical copper-oxide bridge rectifiers which are designed to be mounted in a meter case.

By
H. M. TREMAINE, D.Sc.
University of Hollywood

Power Level and Volume Indicator Meters

A review of the accepted standards used in conjunction with the design and application of db. and vu. meters.

THE measurement of power or program levels in sound circuits is of primary importance to the audio engineer. Meters designed for this purpose are known as "volume indicator (v.i.)" meters and have been in use by the telephone company, radio broadcasting stations, recording companies, and the motion picture industry for many years.

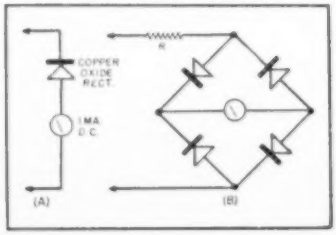
The purpose of these meters, or volume indicators, is to indicate the variation in electrical sound levels. This does not mean that the meter measures the actual volume of sound, but rather the level of voltages generated by the reproducing equipment. Measurement by electrical means is made possible by the fact that the sound intensity is directly proportional to the voltage amplitude in an electrical circuit.

As the voltages generated are of an alternating nature, an a.c. type meter will be required for their measurement. The conventional type a.c. meter used for power measurement is not suitable for this purpose because of its characteristic low impedance and limited response to frequency.

Volume indicator meters are, in reality, sensitive high impedance a.c. voltmeters of wide frequency range, calibrated either in decibels or volume units relative to one of the two existing reference levels in use by the electronic industry. The device may be either electronic or of the copper-oxide rectifier type.

From a study of the waveforms involved in the transmission of speech and music, at first thought it appears that the measuring instrument should respond to the peak or crest of the wave, rather than the r.m.s. value. Further study, however, indicates that either type meter will be satisfactory. Also, it has been found that phase distortion affects the readings of peak indicating meters, although it may not be apparent to the ear, thus possibly causing overloading of the system because of incorrect readings.

Fig. 2. (A) A half-wave rectifier and (B) a full-wave bridge rectifier.



Two terms are in general usage in regard to meters used for audio frequency measurements. They are the volume level indicator and the power level indicator. The first term applies only to meters used for monitoring program material of complex waveforms which is varying in both amplitude and frequency. The second term is applied to meters used for the measurement of sound circuits where steady-state conditions are maintained by using sine wave power.

Power Level Indicator

The principal difference between the volume level indicator and the power level meter is in damping. In the volume level indicator definite characteristics have been standardized by the industry and are built into the meter movement to control its sensitivity, damping, frequency range, and input impedance. In the power level meter, only the frequency range and sensitivity are of importance. Volume level meters may be used to measure both steady-state conditions and complex waveforms; however, this does not apply to power level meters.

In the early days of broadcasting and recording, the volume level indicator was of the electronic type, having characteristics which were considered by its designers to be the most suitable. This situation led to considerable confusion throughout the industry as measurements made in one connection could not be correlated with other measurements. In addition, the meter employed one or more vacuum tubes and required both a high and low voltage source for its operation. This feature restricted the use of these meters to the laboratory or studio control room.

Around 1929 the copper-oxide rectifier volume level indicator made its appearance. This meter employed a 1 ma. d.c. D'Arsonval type movement which utilized a half-wave copper-oxide rectifier connected in series with one side of the meter. See Fig. 2A. This resulted in a fairly sensitive meter which was handicapped, however, by a limited frequency response and poor damping. The use of the half-wave rectifier resulted in a non-symmetrical response to complex waveforms. Later the rectifier was changed to a full-wave bridge type, Fig. 2B, which eliminated the distortion introduced by the half-wave rectifier.

Full-wave rectification is essential in meters used for audio frequency measurements since the human voice consistently generates peaks of greater amplitude for one polarity than the other. Under these conditions it would be impracticable to use half-wave rectification unless the circuits were poled and the meter polarity was fixed. Furthermore, if a bi-directional microphone was in use and it was reversed 180 degrees, the peaks, as indicated by the meter, would also be reversed and, depending on the original polarity,

might cause overloading of the electrical circuits due to the incorrect meter readings.

With the adoption of the full-wave rectifier, the meter sensitivity was increased by replacing the 1 ma. movement with one of 500 microampere sensitivity. A resistance was placed in series with the movement to increase the meter impedance to 5000 ohms and at the same time adjust its sensitivity to some definite reference level. When this meter was introduced, the reference level for audio frequency measurements was 6 milliwatts of power in a 500 ohm circuit. For this amount of power, 1.73 volts is developed across the circuit. The meter movement indicated this 1.73 volt reference point on the scale slightly to the left of its center position. See Fig. 3.

Fig. 3. Panel view of a dual power level indicator, manufactured by Cinema Engineering Co.

Power level meters are used for setting the levels of recording or reproducing systems and are generally connected in the circuit at a point where the signal is distributed to other portions of the system. This point is, as a rule, the bridging bus.

The power level indicator meter is used strictly for steady-state sine wave measurements and is not suitable for monitoring program material as its damping is such that the meter tends to overshoot its mark, thus giving rise to false indications with changing levels.

Three types of meter movements are available for power level indicators: 1. the "high speed" or HS movement used for high speed measurements; 2. the "general purpose" or GP movement work; and 3. the "slow speed" or SS movement which is generally employed in making acoustic measurements. The different types of movements may be identified by the symbols "GP," "SS," or "HS" which appear on the meter face.

To increase the operating range of the meter movement above the reference level, a 5000 ohm "L" type attenuator is placed ahead of the meter. See Fig. 4. The attenuator performs two functions, *i.e.*, it extends the range above the reference level, and permits this extension without affecting the 5000 ohm input impedance. A constant input impedance is essential as it allows the input attenuator setting to be changed during operation without upsetting the impedance of the circuit bridged by the meter.

The "L" type attenuator does not present a constant impedance looking in both directions, but only to the source bridged. The arms R_1 and R_2 are connected mechanically by the common shaft and are varied inversely. Therefore, R_2 may drop to only a few ohms when the attenuator is set to the higher ranges. The loss potentiometer should be thought of as a meter multiplier. For the power level meter, the settings of the attenuator usually start at zero and continue in steps of 1 or 2 db. to at least +30 db. above the reference level. The meter face is calibrated from −10 db. to +6 db. Adding the meter dial readings and the attenuator settings algebraically results in a range of from −10 db. to a +36 db., or a total spread of 46 db.

Copper-oxide instrument rectifiers are approximately 70% efficient and are excellent for rectification at audio frequencies providing the voltage across any one element in the bridge does not exceed 11 volts and that the temperature does not rise above 160 degrees F. With the attenuator placed ahead of the meter, the voltage across the rectifier elements, under normal operating conditions, does not exceed 4 volts. Two typical bridge type rectifiers, designed to be mounted in the meter movement case, are shown in Fig. 1.

The frequency response of the early instrument rectifiers was deficient at frequencies above 6000 cycles, dropping off as much as 4 db. at 10,000 cycles. At first this was attributed to the capacity between the plates of the rectifying elements, but subsequent investigation proved that this was not entirely the case. While it is true that some effect was contributed by the capacity, the major factor was the rectifying qualities of the elements at the higher frequencies.

Present day instrument rectifiers are highly developed and will respond to several hundred thousand cycles-per-second. The frequency response of a typical copper-oxide rectifier is shown in Fig. 5.

The VU. Meter

Because of the inaccuracies inherent in the copper-oxide rectifier power level meter and because of the fact that it was not satisfactory for program monitoring, the development of an entirely new meter was jointly undertaken by the *Bell Telephone Laboratories, Columbia Broadcasting System*, and the *National Broadcasting Company*. The result of this research was the development not only of a new type volume indicator meter but also a new reference level of 1 milliwatt, a

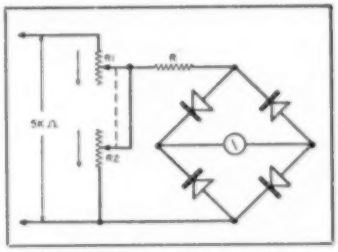


Fig. 4. Circuit diagram of a rectifier-type meter with an "L" type variable attenuator.

unit which was adopted by the electronic industry in May 1939.

This new meter, shown in Fig. 6, is termed a "volume unit (vu.)" meter. This instrument is calibrated in volume units numerically equal to the number of decibels above the reference level of 1 milliwatt of power in a 600 ohm circuit. With this new meter came a new term, "zero dbm.," meaning that the level under discussion is in relation to 1 milliwatt of power in a 600 ohm circuit. In discussing reference levels, the term "dbm." applies only to the 1 milliwatt reference level, while "db." is used to express levels referring to the 6 milliwatt reference level.

The 1 milliwatt reference level has three distinct advantages. It is a unit quantity, hence it is readily applicable to the decimal system, being related to the watt by the factor 10^3 which results in positive values for the majority of measurements. A further advantage of the vu. meter is that all meters of this type are exactly alike in construction and characteristics and, when several are connected across the same circuit, may be tested by the application of a 1000 cycle signal for checking their operation.

VU. Meter Characteristics

The characteristics for the vu. meter were adopted after careful consideration as being most suitable for all applications.

Fig. 5. The frequency response of a conventional copper-oxide instrument rectifier.

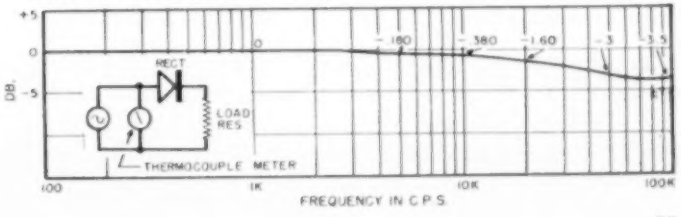


Fig. 6. Panel view of Cinema Engineering Co.'s volume unit (or vu.) meter.

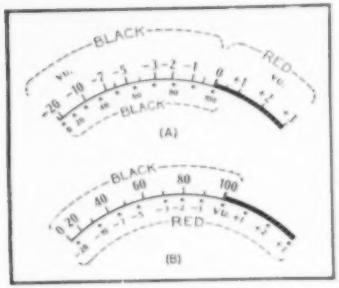


Fig. 7. Two of the scale cards used on vu. meters. (A) Card calibrated in percentages of modulation for b.c. and recording applications. (B) calibrated in db. for general test work and laboratory applications.

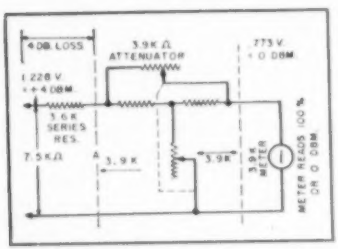


Fig. 8. Circuit diagram of the vu. meter.

1. *General.* The volume indicator employs a d.c. meter movement with a non-corrosive, full-wave, copper-oxide rectifier unit, and responds approximately to the r.m.s. value of the impressed voltage. This will vary somewhat depending on the waveforms and the per-cent harmonics present in the signal.

2. *Scale of instrument.* The face of the instrument may have either of the two scale cards shown in Fig. 7. Each card has two scales, one a vu. scale ranging from −20 to +3 vu., and the other a per-cent voltage scale ranging from 0 to 100 with the 100 point coinciding with the 0 point on the vu. scale. The normal point for reading volume levels is at the 0 vu. or 100 scale point which is located to the right of the center at about 71% of the full-scale arc.

3. *Dynamic characteristics.* With the instrument connected across a 600 ohm external resistance, the sudden application of a sine wave voltage sufficient to give a steady-state deflection at the 0 vu. or 100 scale point, should cause the pointer to overshoot not less than 1% nor more than 1.5% (.15 db.). It should be capable of reaching 99 on the per-cent voltage scale in .3 second.

4. *Response vs. frequency.* The instrument sensitivity should not depart from that at 1000 c.p.s. by more than .2 db. between 35 and 10,000 c.p.s. nor more than .5 db. between 25 and 16,000 c.p.s.

5. *Sensitivity.* The application of a sinusoidal potential of 1.228 volts (4 db. above 1 milliwatt in 600 ohms) to the instrument, in series with the proper external resistance (3600 ohms), will cause a deflection to the 0 vu. or 100% point.

6. *Impedance.* For bridging across a line the volume indicator, including the instrument and proper series resistance (3600 ohms), should have an impedance of 7500 ohms when measured with a sinusoidal voltage sufficient to deflect the meter to the 0 vu. or 100% scale point.

7. *Harmonic distortion.* The harmonic distortion introduced in a 600 ohm circuit when a volume indicator is bridged across it is less than .3% under the worst possible condition (when there is no loss in the variable attenuator).

8. *Overload.* The instrument must be capable of withstanding, without injury or effect on the calibration, peaks of *ten times* the voltage equivalent to a reading of 0 vu. or 100% for .5 second, and a continuous overload of *five times* that voltage.

The selection of the scale for the meter face will depend on its application. For broadcasting and recording purposes where it is desirable to know the percentages of modulation the scale of Fig. 7B is used. For laboratory and general test work the scale of Fig. 7A is employed because most of the readings will be in vu.

The circuit diagram of the complete vu. meter is shown in Fig. 8. The meter movement consists of a 50 microampere d.c. D'Arsonval movement and a full-wave bridge rectifier. The meter impedance, including the rectifier, is 3900 ohms.

A 3900 ohm variable attenuator and a 3600 ohm series resistor are connected ahead of the meter. As a rule, devices which are to be bridged across circuits of 600 ohms should have at least ten times the impedance of the circuit being bridged. Connecting the 3600 ohm resistor ahead of the attenuator provides a bridging impedance of 7500 ohms.

Attenuators designed for use with vu. meters are constructed with the attenuator dial calibrations starting at +4 dbm. and continuing in steps of 2 db. up to +44 dbm. No. 0 dbm. position is provided. The reason for this is that by placing a 3600 ohm resistor ahead of the attenuator to raise the input impedance, a loss of 4 db. is incurred.

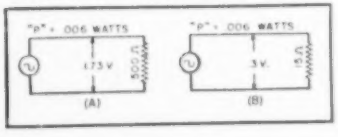
If the 3900 ohm meter movement and the attenuator (the attenuator in its +4 dbm. position has zero loss) is placed across a 600 ohm circuit in which 1 milliwatt of power is flowing, the pointer will be deflected to the 100% or 0 dbm. mark. When the 3600 ohm series resistor is inserted in the circuit the sensitivity of the meter is lowered by 4 db. To bring the deflection back to the 100% mark will now require +4 dbm. at the input.

It is the practice of the telephone company to allow signal levels from +4 dbm. to +8 dbm. to be transmitted over the average cable pair. Thus, with the meter connected as shown in Fig. 8, the 100% mark will indicate a +4 dbm. signal level.

The advantage to be obtained by the use of the vu. meter over the power level and older type v.i. meters are: a 7500 ohm bridging impedance; the 100% or 0 dbm. mark may be set to represent a maximum signal level permitted by the telephone company and if associated with a line feeding a radio transmitter or recording system, it will indicate the percentage of modulation; uniform damping; and frequency response which allows the correlation of measurements with other activities.

An important point to remember in using the attenuator is that the zero calibration point on the meter always becomes that of the attenuator setting and the meter indications are in reference to that setting. The greatest accuracy for either the power level or volume indicator meter lies between the −1 db. and the +1 db. calibration points on the meter scale. Thus, all readings should be made between these points, if possible, by adjusting the input attenuator and then adding the readings algebraically.

Fig. 9. Comparison of voltages in a 500 ohm and 15 ohm circuit for same power.



Power Level Meters

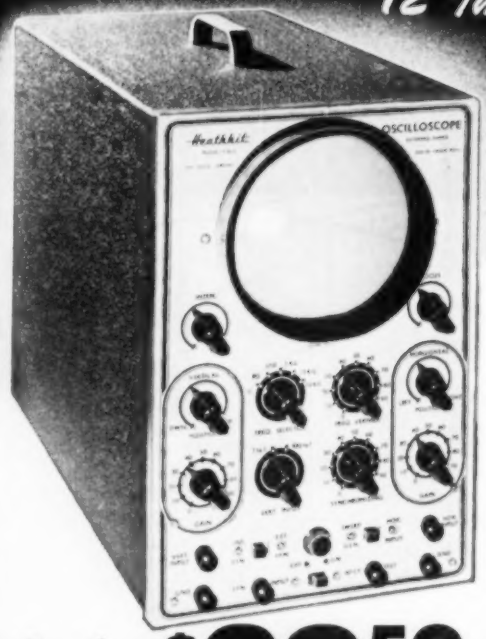
Power level meters are generally calibrated in reference to 6 milliwatts of power in a 500 ohm circuit and if placed across an impedance other than 500 ohms will not read correctly. To obtain the correct reading a "correction factor" is applied to the indicated reading to obtain the true power in the circuit. Fig. 9 demonstrates why the meter does not read correctly.

(Continued on page 94)

12 Improvements IN NEW 1951

MODEL O-6 PUSH-PULL

Heathkit OSCILLOSCOPE KIT



Only $39.50

- ★ New AC and DC push-pull amplifier.
- ★ New step attenuator frequency compensated input.
- ★ New non frequency discriminating input control.
- ★ New heavy duty power transformer has 68% less magnetic field.
- ★ New filter condenser has separate vertical and horizontal sections.
- ★ New intensity circuit gives greater brilliance.
- ★ Improved amplifiers for better response useful to 2 megacycles.
- ★ High gain amplifiers .04 Volts RMS per inch deflection.
- ★ Improved Allegheny Ludlum magnetic metal CR tube shield.
- ★ New synchronization circuit works with either positive or negative peaks of signal.
- ★ New extended range sweep circuit 15 cycles to over 100,000 cycles.
- ★ Both vertical and horizontal amplifier use push-pull pentodes for maximum gain.

The new 1951 Heathkit Push-Pull Oscilloscope Kit is again the best buy. No other kit offers half the features — check them.

Measure either AC or DC on this new scope — the first oscilloscope under $100.00 with a DC amplifier.

The vertical amplifier has frequency compensated step attenuator input into a cathode follower stage. The gain control is of the non frequency discriminating type — accurate response at any setting. A push-pull pentode stage feeds the C.R. tube. New type positioning control has wide range for observing any portion of the trace.

The horizontal amplifiers are direct coupled to the C.R. tube and may be used as either AC or DC amplifiers. Separate binding posts are provided for AC or DC.

The multivibrator type sweep generator has new frequency compensation for the high range it covers; 15 cycles to over 100,000 cycles.

The new model O-6 Scope uses 10 tubes in all — several more than any other. Only Heathkit Scopes have all the features.

New husky heavy duty power transformer has 50% more laminations. It runs cool and has the lowest possible magnetic field. A complete electrostatic shield covers primary and other necessary windings and has lead brought out for proper grounding.

The new filter condenser has separate filters for the vertical and horizontal screen grids and prevents interaction between them.

An improved intensity circuit provides almost double previous brilliance and better intensity modulation.

A new synchronization circuit allows the trace to be synchronized with either the positive or negative pulse, an important feature in observing the complex pulses encountered in television servicing.

The magnetic alloy shield supplied for the C.R. tube is of new design and uses a special metal developed by Allegheny Ludlum for such applications.

The Heathkit scope cabinet is of aluminum alloy for lightness of portability.

The kit is complete, all tubes, cabinet, transformer, controls, grid screen, tube shield, etc. The instruction manual has complete step-by-step assembly and pictorials of every section. Compare it with all others and you will buy a Heathkit. Model O-6. Shipping Wt., 30 lbs.

New INEXPENSIVE MODEL S-2 ELECTRONIC SWITCH KIT

Twice as much fun with your oscilloscope — observe two traces at once — see both the input and output traces of an amplifier, and amazingly you can control the size and position of each trace separately — superimpose them for comparison or separate for observation — no connections inside scope. All operation electronic, nothing mechanical — ideal for classroom demonstrations — checking for intermittents, etc. Distortion, phase shift and other defects show up instantly. Can be used with any type or make of oscilloscope. So inexpensive you can't afford to be without one.

Has individual gain controls, positioning control and coarse and fine switching rate controls — can also be used as square wave generator over limited range. 110 Volt transformer operated comes complete with tubes, cabinet and all parts. Occupies very little space beside the scope. Better get one. You'll enjoy it immensely. Model S-2. Shipping Wt., 11 lbs.

Only $19.50

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The HEATH COMPANY

. . . BENTON HARBOR 15, MICHIGAN

New 1951 • • MODEL V-4A

Heathkit VTVM KIT

HAS EVERY EXPENSIVE *Feature*

- ★ Higher AC input impedance, (greater than 1 megohm at 1000 cycles).
- ★ New AC voltmeter flat within 1 db 20 cycles to 2 megacycles (600 ohm source).
- ★ New accessory probe (extra) extends DC range to 30,000 Volts.
- ★ New high quality Simpson 200 microampere meter.
- ★ New ½% voltage divider resistors (finest available).
- ★ 24 Complete ranges.
- ★ Low voltage range 3 Volts full scale (⅓ of scale per volt).
- ★ Crystal probe (extra) extends RF range to 250 megacycles.
- ★ Modern push-pull electronic voltmeter on both AC and DC.
- ★ Completely transformer operated isolated from line for safety.
- ★ Largest scale available on streamline 4½ inch meter.
- ★ Burn-out proof meter circuit.
- ★ Isolated probe for dynamic testing no circuit loading.
- ★ New simplified switches for easy assembly.

New LOW PRICE **$23.50**

The new Heathkit Model V-4A VTVM Kit measures to 30,000 Volts DC and 250 megacycles with accessory probes — think of it, all in one electronic instrument more useful than ever before. The AC voltmeter is so flat and extended in its response it eliminates the need for separate expensive AC VTVM's. + or − db from 20 cycles to 2 megacycles. Meter has decibel ranges for direct reading. New zero center on meter scale for quick FM alignment.

There are six complete ranges for each function. Four functions give total of 24 ranges. The 3 Volt range allows 33⅓% of the scale for reading one volt as against only 20% of the scale on 5 Volt types.

The ranges decade for quick reading.

New ½% ceramic precision are the most accurate commercial resistors available — you find the same make and quality in the finest laboratory equipment selling for thousands of dollars. The entire voltage divider decade uses these ½% resistors.

New 200 microampere 4½" streamline meter with Simpson quality movement. Five times as sensitive as commonly used 1 MA meters.

Shatterproof plastic meter face for maximum protection.

Both AC and DC voltmeter use push-pull electronic voltmeter circuit with *burn-out* proof meter circuit.

Electronic ohmmeter circuit measures resistance over the amazing range of 1/10 ohm to one billion ohms all with internal 3 Volt battery. Ohmmeter batteries mount on the chassis in snap-in mounting for easy replacement.

Voltage ranges are full scale 3 Volts, 10 Volts, 30 Volts, 100 Volts, 300 Volts, 1000 Volts. Complete decading coverage without gaps.

The DC probe is isolated for dynamic measurements. Negligible circuit loading. Gets the accurate reading without disturbing the operation of the instrument under test. Kit comes complete, cabinet, transformer, Simpson meter, test leads, complete assembly and instruction manual. Compare it with all others and you will buy a Heathkit. Model V-4A. Shipping Wt., 8 lbs. Note new low price, $23.50

New 30,000 VOLT DC PROBE KIT

Beautiful new red and black plastic high voltage probe. Increases input resistance to 1100 megohms, reads 30,000 Volts on 300 Volt range. High input impedance for minimum loading of weak television voltages. Has large plastic insulator rings between handle and point for maximum safety. Comes complete with PL55 type plug.

No. 309 High Voltage Probe Kit. Shipping Wt., 2 pounds. **$5.50**

Heathkit RF PROBE KIT

Crystal diode probe kit extends range to 250 megacycles ± 10%, comes complete with all parts, crystal, cable and PL55 type plug.

No. 309 RF Probe Kit. Shipping Wt., 1 lb. **$5.50**

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The HEATH COMPANY

. . . BENTON HARBOR 15, MICHIGAN

NEW Heathkit T. V. ALIGNMENT GENERATOR KIT

Shipping Wt., 16 lbs.

$39.50

- ★ New simplified circuit for easy calibration and assembly.
- ★ New 2 band built-in marker covers 19 to 75 Mc.
- ★ New dual spider sweep motor for long life.
- ★ New blanking circuit gives base line for better alignment.
- ★ New variable oscillator gives high output fundamentals on high TV band.
- ★ New standby switch keeps instrument ready for instant use.
- ★ New 6 to 1 slow speed drive on both master oscillator and marker tuners.

The new Heathkit TV Alignment Generator incorporates the new developments required for modern TV servicing. An absorption marker circuit covering all possible IF bands and even several of the RF bands. The new blanking circuit provides a base reference line which is invaluable in establishing proper traces. The new sweep motor incorporates dual spiders in the speaker frame assuring better alignment and long life. The mounting of the speaker sweep motor has been simplified for easy alignment.

The variable master oscillator covers 140 to 250 Mc. thus giving high output fundamentals where they are most needed. Low band coverage 2 Mc. to 50 Mc.

A new step attenuator provides excellent control of output.

Planetary 6 to 1 drives on both oscillator and marker provides smooth easy control settings.

A standby position is provided making the instrument always instantly available.

Horizontal sweep voltage with phasing control is provided. No other sweep generator under $100.00 provides all these features — comes complete with instruction manual. Model TS-2.

Heathkit CONDENSER CHECKER KIT

Only

$19.50

Features

- Power factor scale.
- Measures resistance.
- Measures leakage.
- Checks paper-mica-electrolytics.
- Bridge type circuit.
- Magic eye indicator.
- 110 V. transformer operated.
- All scales on panel.

Checks all types of condensers over a range of .00001 MFD to 1,000 MFD. All on readable scales that are read direct from the panel. NO CHARTS OR MULTIPLIERS NECESSARY. A condenser checker anyone can read. A leakage test and polarizing voltage for 20 to 500 Volts provided. Measures power factor of electrolytics between 25 and 50%. 110 V. 60 cycle transformer operated complete with rectifier and magic eye tube, cabinet, calibrated panel, test leads and all other parts. Clear detailed instructions for assembly and use. Model C-2. Shipping Wt., 7 lbs.

NEW Heathkit SIGNAL TRACER AND UNIVERSAL TEST SPEAKER KIT

$19.50

Features

- High sensitivity.
- Complete set of speaker impedances.
- Tests microphones and PA systems.
- Tests both single and push-pull speaker circuits.

The popular Heathkit Signal Tracer has now been combined with a universal test speaker at no increase in price. The same high quality tracer follows signal from antenna to speaker — locates instruments — defective parts quicker — saves valuable service time — gives greater income per service hour. Works equally well on broadcast — FM or TV receivers. The test speaker has a assortment of matching ranges to match push-pull or single output impedance. Also test microphones, pickups, PA systems — comes complete — cabinet, 110 V. 60 cycle, power transformer — tubes, test probe, all parts and detailed instructions for assembly and use. Model T-2. Shipping Wt., 8 lbs.

Heathkit TUBE CHECKER KIT

Features

Sockets for every modern tube — blank for new types.

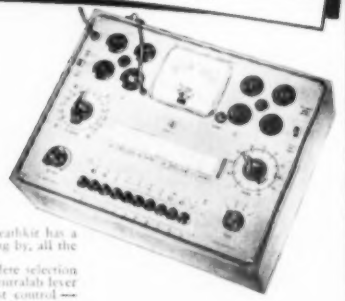
Fastest method of testing tubes — saves time — makes more profit.

Rugged counter type birch cabinet.

Gear driven roller chart gives instant setup for all types.

Tests each element separately for open or short and quality.

Beautiful 3 color meter — reads good-bad and line set point.



Test your tubes the modern way — dynamically — the simplest, yet fastest and surest method — your Heathkit has a switch for each tube element and measures that element — no chance for open or shorted elements slipping by, all the advantages of the mutual conductance type without the slow cumbersome time consuming setups.

Your Heathkit Tube Checker has all the features — beautiful 3 color BAD-GOOD meter — complete selection of voltages — roller chart listing hundreds of tubes including the new 9 pin miniatures — finest quality Centralab lever switches for each element — high grade birch counter type cabinet — continuously variable line adjust control — every feature you need to sell tubes properly. The most modern type tube checker with complete protection against obsolescence. The best of parts — rugged oversize 110 V. 60 cycle power transformer — finest of Mallory and Centralab switches and controls, complete set of sockets for all type tubes with blank spare for future types. Fast action brass gear driven roller chart quickly locates the settings for any type tube. Simplified switching cuts necessary testing time to minimum and saves valuable service time. Short and open element check. Simple method allows instant setup of new tube types without waiting for factory data. No matter what the arrangements of tube elements, the Heathkit flexible switching arrangement easily handles it. Order your Heathkit Tube Checker Kit today. See for yourself that Heath again saves you two-thirds and yet retains all the quality — this tube checker will pay for itself in a few weeks — better assemble it now. Complete with instructions — pictorial diagrams — all parts — cabinet — ready to wire up and operate. Model TC-1 Shipping Wt., 12 lbs.

$29.50

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. . . BENTON HARBOR 15, MICHIGAN

NEW 1951

Heathkit SIGNAL GENERATOR KIT

Features

- Sine wave audio modulation.
- Extended range 160 Kc. to 50 megacycles fundamentals.
- New step attenuator output.
- New miniature HF tubes.
- Transformer operated for safety.
- Calibrated harmonics to 150 megacycles.
- New external modulation switch.
- 5 to 1 vernier tuning for accurate settings.

A completely new Heathkit Signal Generator Kit. Dozens of improvements. The range on fundamentals has been extended to over 50 megacycles, makes this Heathkit ideal as a marker oscillator for T.V. New step attenuator gives controlled outputs from very low values to high output. A continuously variable control is used with each step. New miniature HF tubes are required for the high frequencies covered.

Uses 6C4 master oscillator and 6C4 sine wave audio oscillator. The set is transformer operated and a husky selenium rectifier is used in the power supply. The coils are precision wound and checked for calibration making only one adjustment necessary for all bands.

New sine wave audio oscillator provides internal modulation and is also available for external audio testing. Switch provided allows the oscillator to be modulated by an external audio oscillator for fidelity testing of receivers.

A best buy — think of all the features for less than $20.00. The entire coil and tuning assembly are assembled on a separate turret for quick assembly — comes complete — all tubes — cabinet — test leads — every part. The instruction manual has step-by-step instructions and pictorials. It's easy and fun to build a Heathkit Model SG-6 Signal Generator. Shipping Wt., 7 lbs.

$19.50

Heathkit SINE AND SQUARE WAVE AUDIO GENERATOR KIT

Either sine or square wave.
Stable RC bridge circuit.
Covers 20 to 20,000 cycles.
Less than 1% distortion.

Hundreds of Heathkit Audio Generators are used by speaker manufacturers—definite proof of their quality and dependability. The added feature of square wave opens up an entirely new field of amplifier testing. Uses the best of parts, 4 gang condenser, 1% calibrating resistors, metal cased filter condensers, 5 tubes, completely calibrated panel and detailed instruction manual. One of our best and most useful kits. Model G-2. Shipping Wt., 12 lbs.

$34.50

THE NEW Heathkit HANDITESTER KIT

- Beautiful streamline Bakelite case.
- AC and DC ranges to 5,000 Volts.
- 1% Precision ceramic resistors.
- Convenient thumb type adjust control.
- 400 Microampere meter movement.
- Quality Bradley AC rectifier.
- Multiplying type ohms ranges.
- All the convenient ranges 10-30-300-1,000-5,000 Volts.
- Large quality 3" built-in meter.

A precision portable volt-ohm-milliammeter. An ideal instrument for students, radio service, experimenters, hobbyists, electricians, mechanics, etc. Rugged 400 us meter movement. Twelve complete ranges, precision dividers for accuracy. Easily assembled from complete instructions and pictorial diagrams. An hour of assembly saves one-half the cost. Order today. Model M-1. Shipping Wt., 2 lbs.

$13.50

NEW Heathkit BATTERY ELIMINATOR KIT

Features

- Provides variable DC voltage for all checks.
- Locates sticky vibrators-intermittents.
- Voltmeter for accurate check.
- Has 4000 MFD Mallory filter for ripple-free voltage.

Even the smallest shop can afford the Heathkit Battery Eliminator Kit. A few auto radio repair jobs will pay for it. It's fast for service, the voltage can be lowered to find sticky vibrators or raised to ferret out intermittents. Provides variable DC voltage 5 to 7½ Volts at 10 Amperes continuous or 15 Amperes intermittent. Also serves as storage battery charger. Ideal for all auto radio testing and demonstrating.

A well filtered rugged power supply uses heavy duty selenium rectifier, choke input filter with 4,000 MFD of electrolytic filter for clean DC. 0-15 V. voltmeter indicates output which is variable in eight steps. Easily constructed in a few hours from our instructions and diagrams — better be equipped for all types of service — it means more income. Model BE-2. Shipping Wt., 19 lbs.

$22.50

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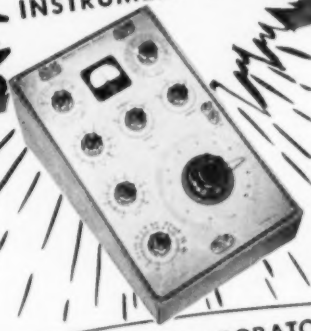
New LABORATORY INSTRUMENT KITS

HUNDREDS OF LABORATORIES USE

Heathkit IMPEDANCE BRIDGE as Standard



Features

● Measures inductance 10 microhenries to 100 henries ● Measures resistance .01 ohms to 10 megohms ● Measures capacitance .00001 MFD to 100 MFD ● Measures "Q" and power factor.

Measures inductance from 10 microhenries to 100 henries, capacitance from .00001 MFD to 100 MFD. Resistance from .01 ohms to 10 megohms. Dissipation factor from .001 to 1. "Q" from 1 to 1,000. Ideal for schools, laboratories, service shops, serious experimenters. An impedance bridge for everyone — the most useful instrument of all, which heretofore has been out of the price range of serious experimenters and service shops. Now at the lowest price possible. All highest quality parts. General Radio main calibrated control. General Radio 1,000 cycle hummer. Mallory ceramic switches with 60 degree indexing — 200 microamp type binding posts with standard ¾" centers. Beautiful birch cabinet. Directly calibrated "Q" and dissipation factor scales. Ready calibrated capacity and inductance standards of Silver Mica, accurate to ½ of 1% and with dissipation factors of less than 50 parts in one million. Provisions on panel for external generator and detector. Measure all your unknowns the way laboratories do — with a bridge for accuracy and speed.

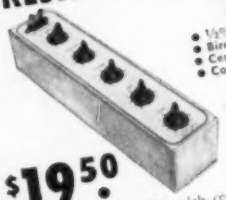
$69.50

Internal 6 Volt battery for resistance and hummer operations. Circuit utilizes Wheatstone, Hay and Maxwell circuits for different measurements. Supplied complete with every quality part — all calibrations completed and instruction manual for assembly and use. Deliveries are limited. Model IB-1. Shipping Wt., 15 lbs.

NEW Heathkit LABORATORY

RESISTANCE DECADE KIT

Features



● ½% Accuracy
● Birch Cabinet
● Ceramic Switches
● Covers 1 ohm to 99,999 ohms

$19.50

The new Heathkit Resistance Decade is a handy tool for laboratory, school and service shop. Ideal for test setups, calibrating instruments, bridge measurements, selecting multipliers, etc.

Uses the finest Centralab ceramic switches, 1% ceramic decade resistors and heavy birch cabinet matching other laboratory equipment. The range is 1 ohm to 99,999 ohms in one ohm steps.

Finest quality throughout to withstand school usage — heavy aluminum panel — laboratory type binding posts — the fine decades are extremely simple to assemble — complete kit. Model RD-1. Shipping Wt., 4 lbs.

NEW Heathkit LABORATORY

POWER SUPPLY KIT

Features

● Supplies 6.3 V. AC at 4.5 Amps.
● Heavy duty construction.
● Handy for schools, labs., and service shops.
● Supplies variable DC 50-300 Volts.
● Shows voltage or current on 3½" meter.

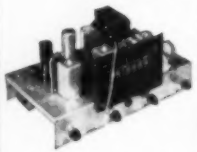
$29.50

This new Heathkit Variable Power Supply Kit fills hundreds of needs — use it for experimental circuits — no need to build a separate power supply — use it for a test voltage to determine proper coefficients in unknown circuits — calibrate instruments with its variable voltage, etc. This new Heathkit supplies 50 to 300 Volts continuously variable DC, together with an AC filament voltage of 6.3 Volts at 4.5 Amperes. A built-in 1 MA 3½" meter has proper shunts to read 0-500 Volts and 0-200 Milliamperes. The circuit uses a 5Y3 rectifier, two 1619 tubes as electronic control tubes to vary the output voltage with a single potentiometer. Case measures 7⅝" x 13" x 7⅛". Has instruction manual for assembly and use. Model PS-1. Shipping Wt., 18 lbs.

Heathkit RECEIVER & TUNER KITS for AM and FM

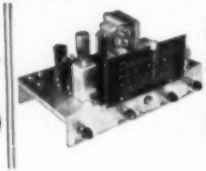
TWO HIGH QUALITY Heathkit SUPERHETERODYNE

RECEIVER KITS



Model BR-1 Broadcast Model Kit covers 550 to 1600 Kc. Shipping Wt., 10 pounds.

$19.50



Model AR-1 3 Band Receiver Kit covers 550 Kc. to over 20 Mc. continuous. Extremely high sensitivity. Shipping Wt., 10 lbs.

$23.50

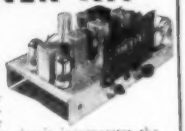
Two new Heathkits. Ideal for schools, replacement of worn out receivers, amateurs and custom installations.

Both are transformer operated quality units. The best of materials are used throughout — six inch calibrated slide rule dial — quality power and output transformers — dual iron core shielded I.F. coils — metal filter condensers and all other parts. The chassis has phono input jack — 110 Volt outlet for phono motor and there is a phono-radio switch on panel. A large metal panel simplifying installation in used console cabinets is included. Comes complete with tubes and instruction manual incorporating pictorials and step-by-step instructions (less speaker and cabinet). The three band model has simple coil turret which is assembled separately for ease of construction.

TRUE FM FROM Heathkit

FM TUNER KIT

$22.50



The Heathkit FM Tuner Model FM-2 was designed for best possible tonal reproduction. The circuit incorporates the most desirable FM features — true FM — ready wound and adjusted coils — 3 stages of 10.7 Mc. I.F. (including limiter).

Tube lineup: 7E5 oscillator, 6SH7 mixer, two 6SH7 I.F. stages, 6SH7 limiter, two 7C4 diodes as discriminator, 6X5 rectifier.

The instrument is transformer operated making it safe for connection to any type receiver or amplifier. The R.F. coils are ready wound — mounted on the tuning condenser and the condenser is adjusted — no R.F. coils to wind or adjust.

A calibrated six inch slide rule dial has vernier drive for easy tuning. The finest parts are provided with all tubes, punched and formed chassis, transformers, condensers and complete instruction manual. Model FM-2. Shipping Wt., 10 lbs.

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ENJOY MUSIC AT ITS *Finest* WITH *Heathkit* AMPLIFIERS

NEW *Heathkit* HIGH FIDELITY 20 WATT AMPLIFIER KIT

$21.50

Features

- Push-pull 6L6's.
- Full 20 Watts output.
- Fully enclosed chassis.
- Provisions for reluctance pickup compensation stage.
- Cased high fidelity output transformer.
- Treble and bass boost tone controls.
- Full range of output impedances 3.2 ohms to 500 ohms.

The finest amplifier kit we have ever offered — check the features. This inexpensive amplifier compares favorably with instruments costing five times as much. Nothing has been spared to provide the best reproduction — an ideal amplifier for the new Heathkit FM Tuner listed below.

Dual tone controls for control of both treble and bass. Bass control is of the boost type for maximum listening pleasure. Optional preamplifier stage for use with G. E. reluctance pickup or microphone. Uses inverse feedback to give excellent response over entire range. Tube lineup: 6SJ7 preamplifier stage, 6J5 phase splitter stage, two 6L6's in push-pull and 5Y3 rectifier. (6SC7 as optional compensation stage).

Uses highest quality Chicago Transformer Corporation cased output transformer with taps of 3.2, 8, 15, 60 and 500 ohms to match any speaker combination. Power transformer is conservatively rated for continuous operation in sound systems. Tone control gives maximum bass boost of 6 db at 70 cycles. Amplifier has maximum gain of 75 db. Response within 5 db 20 to 20,000 cycles. Shipping Wt., 17 lbs. Complete with all parts, tubes and instruction manual.

Model A-5A Amplifier with preamplifier for G. E. cartridges or microphone **$23.50**
12" 20 Watt Speaker, No. 520 **7.50**

Heathkit ECONOMY 6 WATT PUSH-PULL AMPLIFIER KIT

$12.50

No. 304, 12-inch Speaker **$6.95**

This new Heathkit Amplifier was designed to give quality reproduction at a very low price. Has two preamp stages, phase inverter stage and push-pull beam power output. Comes complete with six tubes, quality output transformer (4 to 8-4 ohm voice coil), husky cased power transformer and all other parts. Has tone and volume controls. Instruction manual has pictorial for easy assembly. Six watt output with response flat +- 1½ db from 50 to 15,000 cycles. A quality amplifier kit at new low price. Better build one. Model A-4. Shipping Wt., 7 lbs.

Heathkit RECEIVERS and TUNER CABINETS

$4.95

Order No. 550 for FM tuner

Blonde birch veneer cabinet for either the receivers or tuner. Modern styling is an asset to any room. 5" speaker fits in end of cabinet when used with receivers. Size 7 x 13½ x 8¼ inches. Shipping Wt., 5 lbs.
Order No. 545 for either receiver

Metal professional type communications receiver cabinet. Finished in deep grey to fit the panel supplied with Heathkit BR-1 and AR-1 Receivers (panel shown not included with cabinet). 5" speaker mounts in end of cabinet. Gives professional appearance to Heathkit receivers. Size 7 x 14 x 7¾ inches. Shipping Wt., 6 lbs.

5" Permoflux Speaker for either cabinet for use with either Heathkit Receiver No. 320 5" Speaker **$2.75**

$4.50

No. 555 Cabinet for receivers only

ORDER BLANK

To HEATH COMPANY
BENTON HARBOR 15, MICHIGAN

From

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SHIP VIA
- ☐ Parcel Post
- ☐ Express
- ☐ Freight
- ☐ Best Way

Quantity	Item	Price	Quantity	Item	Price
	Heathkit Oscilloscope Kit — Model O-6			Heathkit VTVM Kit — Model V-4A	
	Heathkit T.V. Alignment Gen. Kit — TS-2			Heathkit R.F. Probe Kit — No. 309	
	Heathkit FM Tuner Kit — FM-2			Heathkit H.V. Probe Kit — No. 336	
	Heathkit Broadcast Receiver Kit — Model BR-1			Heathkit R.F. Signal Gen. Kit — Model SG-6	
	Heathkit Three Band Receiver Kit — Model AR-1			Heathkit Condenser Checker Kit — Model C-2	
	Heathkit Amplifier Kit — Model A-4			Heathkit Handitester Kit — Model M-1	
	Heathkit Amplifier Kit — Model A-5 (or A-5A)			Heathkit Variable Power Supply Kit — Model PS-1	
	Heathkit Tube Checker Kit — Model TC-1			Heathkit Resistance Decade Kit — Model RD-1	
	Heathkit Audio Generator Kit — Model G-2			Heathkit Impedance Bridge Kit — Model IB-1	
	Heathkit Battery Eliminator Kit — Model BE-2			Heathkit Signal Tracer Kit — Model T-2	
	Heathkit Electronic Switch Kit — Model S-2				

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DB. and VU. Meters

(Continued from page 86)

In the diagram a 500 ohm and a 15 ohm circuit are shown. It will be noted that the same amount of power is being dissipated in both circuits; however, the voltage across the circuits is not the same. If a power level meter, calibrated for 500 ohms, is placed across the 500 ohm circuit, it will be deflected to its zero reference mark. Connecting the same meter across the 15 ohm circuit will cause it to read low by 15.22 db. This is true because for the same amount of power the voltage across the 15 ohm circuit is only .3 volt. Thus the meter will not be deflected the same amount as for the 500 ohm circuit where 1.73 volts may be obtained.

The correction factor for any impedance may be obtained with the aid of the following equation: $db.\ correction = 10\ log_{10}\ (Z_1/Z_2)$ (or $10\ log_{10}\ (Z_2/Z_1)$ if the impedance of the circuit is higher than that for which the meter was calibrated) where Z_1 is the impedance for which the meter is calibrated and Z_2 the impedance to be bridged.

As an example, assume that a db. meter calibrated for 500 ohms is connected across a line impedance of 8 ohms with its attenuator set to zero. The signal deflects the pointer to the zero mark. What is the true power level of the circuit? It is $db. = 10\ log_{10}\ (Z_1/Z_2) = 10\ log_{10}\ (500/8) = 10\ log_{10}\ 62.5 = 10 \times 1.796 = 17.96$ db.

The correction factor 17.96 db. is added to the meter reading, thus when the meter indicates zero the true level is +17.96 db. If the meter is placed across an impedance higher than that for which it was originally calibrated, the second equation is used and the correction factor is subtracted from the meter reading. The most commonly used correction factors are given in Table 1.

When a meter is bridged across a circuit a slight power loss takes place. This is called "bridging loss." To determine how much the circuit level will be affected when the meter is bridged across it, the following equation may be used: $db. = 20\ log_{10}\ [(2BR + R)/2BR]$ where BR is the meter impedance and R is the impedance of the circuit bridged.

For example, assume a v.i. meter of 5000 ohms is bridged across a circuit of 500 ohms. What is the bridging loss

Table 1. The most commonly used correction factors for power level meters.

CORRECTION FACTORS		
LINE Z (in ohms)	METER CAL. (500 ohms) (in db.)	METER CAL. (600 ohms) (in db.)
600	−0.791	0.000
500	0.000	+0.791
250	+3.01	+3.80
200	+3.97	+4.77
125	+6.02	+6.81
100	+6.99	+7.78
50	+10.00	+10.79
30	+12.22	+13.01
15	+15.22	+16.02
8	+17.96	+16.75
4	+20.97	+21.76

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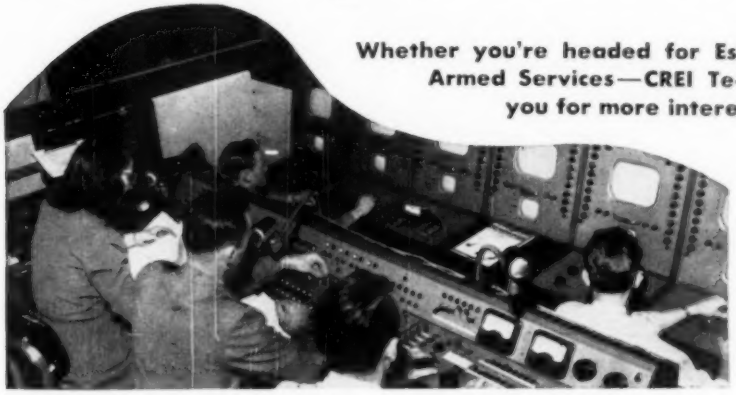

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By E. H. RIETZKE
President CREI

YOUR future success can best be assured by the steps you take today to prepare for it. No field offers a properly qualified young man greater opportunity than electronics. In the Armed Services, electronics gives rockets "brains" to make scientific observations, gives airplanes "eyes" and "ears" to navigate, gives explosives target directions.

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BRIDGING LOSSES		
METER Z (in ohms)	LINE Z (in ohms)	BRIDGING LOSS (in db.)
5000	500	0.42
5000	600	0.51
7500	500	0.28
7500	600	0.34
10,000	500	0.21
10,000	600	0.26

Table 2. Tabulation of bridging losses for lines of different impedances and volume indicator meters of various bridging impedances. See text for the related formulas.

in decibels? It is $db. = 20\ log_{10}\ [(2BR + R^2)/2BR] = 20\ log_{10}\ [(10{,}000 + 500)/10{,}000] = 20\ log_{10}\ 1.05 = 20 \times .0212 = .424$ db. Thus, when the meter is bridged across the circuit the original level will be lowered by .424 db. Generally speaking, unless very precise measurements are to be made, this small loss in level may be ignored. Bridging losses for lines of different impedances and v.i. meters of various bridging impedances are shown in Table 2.

The difference in decibels between any two reference levels may be determined by the equation $db. = 10\ log_{10}\ P_1/P_2$. For example, the difference between a reference level of 1 milliwatt and one of 6 milliwatts would be: $db. = 10\ log_{10}\ P_1/P_2 = 10\ log_{10}\ 6/1 = 10\ log_{10} 6 = 10 \times .778 = 7.78$ db.

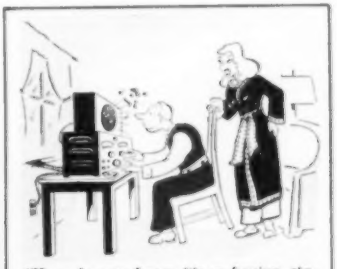
Conclusion

In closing it might be well to mention that copper-oxide rectifier meters, irrespective of type, will at times introduce distortion into the circuit being bridged, if used in conjunction with distortion measuring equipment. The vu. attenuator should be set to its maximum position after the proper level has been obtained and then the distortion reading should be taken.

The distortion introduced by the vu. meter is caused by the rectifier clipping the peaks of the impressed waveforms. The amount of distortion introduced will depend on how much isolation is provided by the attenuator network resistance.

Another precaution which should be taken is that since the vu. meter is designed to be mounted on dural or aluminum panels because of the high coercive force magnet used in the movement, the shunting effect of the steel on the magnetic circuit reduces the flux and affects the meter characteristics if the meters are mounted on steel panels.

—30—



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TUBE TESTERS

THE NEW MODEL 247

Check octals, loctals, bantam jr., peanuts, television miniatures, magic eye, hearing aids, thyratrons, the new type H.F. miniatures, etc.

Features:

★ A newly designed element selector switch reduces the possibility of obsolescence to an absolute minimum.

★ When checking Diode, Triode and Pentode sections of multi-purpose tubes, sections can be tested individually. A special isolating circuit allows each section to be tested as if it were in a separate envelope.

★ The Model 247 provides a supersensitive method of checking for shorts and leakages up to 5 Megohms between any and all of the terminals.

★ One of the most important improvements, we believe, is the fact that the 4-position fast-action snap switches are all numbered in exact accordance with the standard R.M.A. numbering system. Thus, if the element terminating in pin No. 7 of a tube is under test, button No. 7 is used for that test.

$29.90 NET

Model 247 comes complete with new speed-read chart. Comes housed in handsome hand-rubbed oak cabinet sloped for bench use. A slip-on portable hinged cover is indicated for outside use. Size: 10¼"x8¼"x5¼".

SUPERIOR'S NEW MODEL TV-10

★ Tests all tubes including 4, 5, 6, 7, Octal, Lock-in, Peanut, Bantam, Hearing-Aid, Thyratron, Miniatures, Sub-Miniatures, Novals, etc. Will also test Pilot Lights.

★ Tests by the well-established emission method for tube quality, directly read on the scale of the meter.

★ Tests for "shorts" and "leakages" up to 5 Megohms.

★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TV-10 as any of the pins may be placed in the neutral position when necessary.

★ The TV-10 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

★ Newly designed Line Voltage Control compensates for variation of any line voltage between 105 Volts and 130 Volts.

★ Free-moving built-in roll chart with complete data on all tubes.

The Model TV-10 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover.

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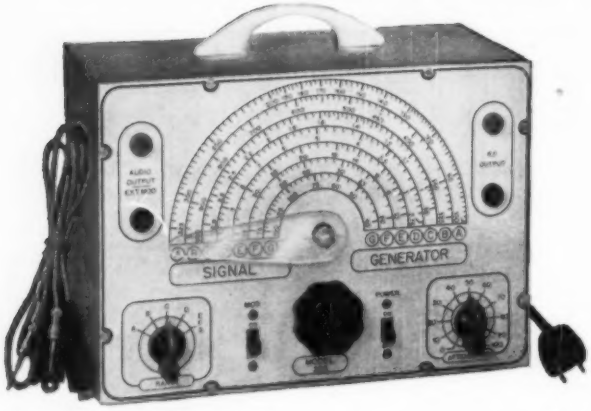
THE NEW MODEL 200 **AM and FM**

SIGNAL GENERATOR



SPECIFICATIONS

★ **R.F. FREQUENCY RANGES:** 100 Kilocycles to 150 Megacycles.

★ **MODULATING FREQUENCY:** 400 Cycles. May be used for modulating the R. F. signal. Also available separately.

★ **ATTENUATION:** The constant impedance attenuator is isolated from the oscillating circuit by the buffer tube. Output impedance of this model is only 100 ohms. This low impedance reduces losses in the output cable.

★ **OSCILLATORY CIRCUIT:** Hartley oscillator with cathode follower buffer tube. Frequency stability is assured by modulating the buffer tube.

★ **ACCURACY:** Use of high-Q permeability, tuned coils adjusted against 1/10th of 1% standards assures an accuracy of 1% on *all ranges from 100 Kilocycles to 10 Megacycles* and an accuracy of 2% on the higher frequencies.

★ **TUBES USED:** 12AU7—One section is used as oscillator and the second is modulated cathode follower. T-2 is used as modulator. 6C4 is used as rectifier.

The Model 200 operates on 110 Volts A.C. Comes complete with output cable and operating instructions.

$18.85 NET

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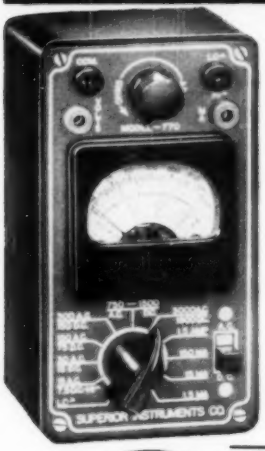

SUPERIOR'S new model 770

AN ACCURATE POCKET-SIZE VOLT-OHM MILLIAMMETER

(SENSITIVITY: 1000 OHMS PER VOLT)

FEATURES

★ Compact-measure 3⅛" x 5⅞" x 2¼".
★ Uses latest design 2% accurate 1 Mil. D'Arsonval type meter.
★ Same zero adjustment holds for both resistance ranges. It is not necessary to readjust when switching from one resistance range to another. This is an important time-saving feature never before included in a V.O.M. in this price range.
★ Housed in round-cornered, molded case.
★ Beautiful black etched panel. Depressed letters filled with permanent white, insures long-life even with constant use.

The Model 770 comes complete with self-contained batteries, test leads and all operating instructions.

SPECIFICATIONS

6 A.C. VOLTAGE RANGES: 0—15/30/150/300/1500/3000 VOLTS

6 D.C. VOLTAGE RANGES: 0—7.5/15/75/150/750/1500 VOLTS

4 D.C. CURRENT RANGES: 0—1.5/15/150 MA. 0—1.5 AMPS.

2 RESISTANCE RANGES: 0—500 OHMS 0—1 MEGOHM

$13.90 NET

SUPERIOR'S new model 670

SUPER-METER

A COMBINATION **VOLT-OHM MILLIAMMETER PLUS CAPACITY REACTANCE INDUCTANCE AND DECIBEL MEASUREMENTS**

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5 Amperes
RESISTANCE: 0 to 500/100,000 Ohms 0 to 10 Megohms
CAPACITY: .001 to .2 Mfd. .1 to 4 Mfd. (Quality test for electrolytics)
REACTANCE: 700 to 27,000 Ohms 13,000 Ohms to 3 Megohms
INDUCTANCE: 1.75 to 70 Henries 35 to 8,000 Henries
DECIBELS: −10 to +18 +10 to +38 +30 to +58

ADDED FEATURE:

The Model 670 includes a special GOOD-BAD scale for checking the quality of electrolytic condensers at a test potential of 150 Volts.

The Model 670 comes housed in a rugged, crackle-finished steel cabinet complete with test leads and operating instructions. Size 5½" x 7½" x 3".

$28.40 NET

SUPERIOR'S *new model TV-20*

20,000 OHMS PER VOLT MULTI-METER *and* TELEVISION KILOVOLTMETER

SPECIFICATIONS

- 9 D. C. VOLTAGE RANGES: (At 20,000 ohms per Volt) 0-2.5-10-50-100-250-500-1,000-5,000-50,000 Volts
- 8 A. C. VOLTAGE RANGES: (At 1,000 ohms per Volt) 0-2.5-10-50-100-250-500-1,000-5,000 Volts
- 5 D. C. CURRENT RANGES 0-50 Microamperes 0-5-50-500 Milliamperes 0-5 Amperes
- 4 RESISTANCE RANGES: 0-2,000-20,000 ohms 0-2-20 Megohms
- 7 D. B. RANGES: (All D. B. ranges based on ODb = 1 Mw. into a 600 ohm line)
  − 4 to + 10 db + 36 to + 50 db
  + 8 to + 22 db + 42 to + 56 db
  + 22 to + 36 db + 48 to + 62 db
  + 28 to + 42 db
- 7 OUTPUT VOLTAGE RANGES: 0 to 2.5-10-50-100-250-500-1,000 Volts

ADDED FEATURE:

The Model TV-20 includes an Ultra High Frequency Voltmeter Probe. A Silicon V. H. F. Diode together with a resistance capacity network provides a frequency range up to 1,000 MEGACYCLES. When plugged into the Model TV-20, the V. H. Probe converts the unit into a Negative Peak-Reading H. F. Voltmeter which will measure gain and loss in all circuits including F. M. and T. V.; check capacity and impedance, test efficiency of all oscillator circuits, measure band-width of F. M. and T. V.; etc.

$39.95 NET

The Model TV-20 operates on self-contained batteries. Comes housed in beautiful hand-rubbed oak cabinet complete with portable cover. Built-in High Voltage Probe. H. F. Probe. Test Leads and all operating instructions. Measures 4½" x 10¼" x 11½". Shipping Weight 10 lbs.

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Superior's model CA-12

SIGNAL TRACER

THE WELL KNOWN MODEL CA-12 IS THE ONLY SIGNAL TRAILER IN THE LOW PRICE RANGE INCLUDING BOTH METER AND SPEAKER!!!

SPECIFICATIONS

- ★ Comparative Intensity of the signal is read directly on the meter—quality of the signal is heard in the speaker.
- ★ Simple to Operate—only one connecting cable—no tuning controls.
- ★ Highly Sensitive—uses an improved vacuum-tube voltmeter circuit.
- ★ Tube and Resistor Capacity Network are built into the detector probe.
- ★ Built-in High Gain Amplifier—Alnico V Speaker.
- ★ Completely Portable—weighs 8 pounds—measures 5½" x 6½" x 9".

MODEL CA-12 COMES COMPLETE WITH ALL LEADS AND OPERATING INSTRUCTIONS

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Superior's new model TV-30

TELEVISION SIGNAL GENERATOR

ENABLES ALIGNMENT OF TELEVISION I. F. AND FRONT ENDS WITHOUT THE USE OF AN OSCILLOSCOPE!

FEATURES Built-in modulator may be used to modulate the R. F. Frequency, also to localize the cause of trouble in the audio circuits of T. V. Receivers.

Double shielding of oscillatory circuit assures stability and reduces radiation to absolute minimum.

Provision made for external modulation by A. F. or R. F. source to provide frequency modulation.

All I. F. frequencies and 2 to 13 channel frequencies are calibrated direct in Megacycles on the Vernier dial. Markers for the Video and Audio carriers within their respective channels are also calibrated on the dial.

Linear calibrations throughout are achieved by the use of a Straight Line Frequency Variable Condenser together with a permeability trimmed coil.

Stability assured by cathode follower buffer tube and double shielding of component parts.

SPECIFICATIONS Frequency Range: 4 Bands—No switching; 18-32 Mc., 35-65 Mc., 54-98 Mc., 150-250 Mc.

Audio Modulating Frequency: 400 cycles (Sine Wave). Attenuator: 4 position, ladder type with constant impedance control for fine adjustment. Tubes Used: 6C4 as Cathode follower and modulated buffer. 6C4 as R.F. Oscillator. 6SN7 as Audio Oscillator and power rectifier.

Model TV-30 comes complete with shielded co-axial lead and all operating instructions. Measure 6" x 7" x 9". Shipping Weight 10 lbs.

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What's New in Radio

For additional information on any of the items described herein, readers are asked to write direct to the manufacturer. By mentioning RADIO & TELEVISION NEWS, the page, and the issue number, delay will be avoided.

SWR BRIDGE

A new and compact standing wave ratio bridge has been designed and is being produced by *James Millen Manufacturing Company, Inc.* of Malden, Massachusetts.

Designated Catalogue number 90671, the new bridge is of the resistance

type and is intended to be used with coaxial lines of either the 52 or 75 ohm type. The compact size of the bridge, 4¼" x 2¼" x 1⅝", makes it convenient to use in almost any location. It will work with any low range d.c. instrument such as a 0-1 milliammeter thus making possible an inexpensive means for obtaining certain necessary transmitter measurements.

REGULATED POWER SUPPLY

Kepco Laboratories, Inc. of 149-14 41st Ave., Flushing, New York, has recently introduced a new voltage regulated power supply, the Model 515.

The new instrument features one regulated "B" supply, one regulated "C" supply, and one unregulated filament supply. The "B" supply is continuously variable from 0 to 500 volts and delivers from 0 to 200 ma. In the range 20 to 500 volts the output voltage variation is less than ½% for both line fluctuations from 105 to 125 volts and load variations from minimum to maximum current. Ripple is less than 5 millivolts.

The "C" supply is continuously variable from 0 to 150 volts and delivers 5 ma. For all output voltages the output voltage variation is less than 10 millivolts for line fluctuations of 105 to 125 volts. At 150 volts, the regulation is less than ½% between 0 and 5 ma. At other settings below 150 volts the internal resistance of the supply will increase to a maximum of 25,000 ohms. Ripple is less than 5 millivolts. The a.c. output is 6.3 volts, 10 amperes, center-tapped and unregulated.

The power supply is designed for relay rack mounting or bench use. It measures 19" wide, 10½" high, and 13" deep.

TUBE PULLERS

Macgowan Electric Specialty Company of 5040 Thomas Avenue So., Minneapolis 10, Minnesota, is currently in production on a handy tube puller designed for the service technician.

Available in four models, the "EE-Zee" tube pullers lift out tubes by wedging between the base and socket without applying strain to the glass. Tubes are held securely while extracting and there is no need to touch hot

tubes. The puller will also extract small vibrators and pull knobs.

The large straight and angle models handle metal, GT, loctal, and most regular glass tubes, while the small straight and angle models handle the miniature type tubes.

Additional details and prices are available on request from the company.

STORAGE BINS

In the interest of speeding servicing operations, facilitating ordering, and increasing the sale of small parts and fixtures, *Service Parts Systems* of 4607 St. Aubin Street, Detroit, Michigan, has recently introduced two new service bins.

The 700 bin is a wall unit with 100 separate compartments. All are tilted forward to meet the eye and are built on the "cash drawer" principle with rounded bottoms to make parts easier to pick out. Each compartment carries a bin tag holder for labels of part number, price, and specifications. The wall unit is 56 inches high, 44 inches wide, and 12 inches thick at the base.

The 320 bin is an island unit with compartments on both sides of the stand. It provides 320 separate compartments in a unit measuring 65 inches high, 44 inches wide, and 20 inches thick at the base.

All the compartments in both units

lift from the rack for stock rotation and cleaning. Shelves at the top and bottom of the wall unit provide extra space for storage of packaged goods. Both bins are built of 18 and 20 gauge steel and are painted in buff and maroon.

VOLTAGE REGULATORS

A new series of line adjusters has been recently introduced by *Standard Transformer Corporation* of 3580 N. Elston Avenue, Chicago 18, Illinois.

These four units permit operation of electrical devices at 115 volts when the supplied voltage is 65, 75, 90, 100, 115, 130, or 145. They meet power requirements up to 750 va., 50-60 cycles. The line adjuster input is correctable in seven steps by means of a selector switch and indicated by an output voltmeter.

The new units are also useful for altering a 115 volt line above or below

that level. They come equipped with a line cord and plug to fit a standard outlet and a plug-in receptacle to accommodate devices to be operated.

TUBE TESTER KIT

To assist service technicians and dealers in marketing radio tubes, *Electronic Instrument Co., Inc.*, of 276 Newport Street, Brooklyn 12, New York, has just introduced a new counter-display tube tester kit, the Model 625-CK.

The new merchandiser, which features individual switches for separate testing of every tube element, tests conventional receiving and TV tubes including 4, 5, 6, large and small 7, octal, loctal, noval, Hytron, VR, magic

(*Continued on page* 144)

When television won its wings

How multiple uses for airborne cameras and equipment were revealed by experiment

No. 10 in a series outlining high points in television history

Photos from the historical collection of RCA

Mounted in the nose of an airplane, *special RCA airborne television equipment will give ground observers a sharp, clear, bird's-eye view of land and sea.*

• Put a television camera in the nose of an observation plane, and generals—many miles away—can watch and direct the course of a battle. Such, in World War II, was one of the suggested uses of airborne television as an "optic nerve."

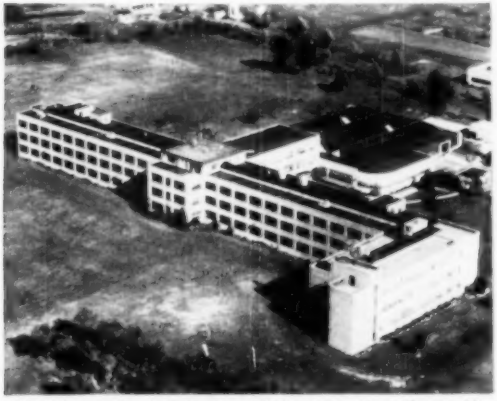
Feasible? Absolutely—yet this is only one of the many ways in which television can serve in fields outside those of news and entertainment. The entire subject of the use of television cameras and receivers in the air has been carefully investigated by RCA.

Not too long ago, at the time when plans for our inter-city television networks were in discussion, the idea of making telecasts from planes high in the air was proposed.

From New York, a plane equipped with a television receiver, set off on a flight to Washington—200 miles away. When above Washington, at an altitude of 18,000 feet, passengers in the plane clearly saw Brig. General David Sarnoff, of RCA, talking to them from Radio City! Later, RCA placed a camera and transmitting equipment in an airliner, and a bird's-eye view of New York was successfully telecast to observers below!

It has also been proposed by authorities, that a television camera might be used as the "eye" of a guided missile. Placed in a rocket's nose it would let a distant operator see where the missile was headed. If need be he could steer it in any direction to hit a moving target.

But less on the destructive side, and more important to us now, are the possible uses of television in "blind flying" conditions, when airports would normally be closed in from bad weather. With a television receiver in the cockpit, and a transmitter sending information from the landing field ahead, the pilot could clearly see conditions on runways and approaches—come in with far greater security than when guided by radio alone!

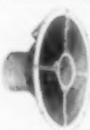


RCA Laboratories in Princeton, N. J., *as seen from the air. New uses for television—including, for example, its adaptation to aviation—are one part of this progressive institution's research program.*

Radio Corporation of America
WORLD LEADER IN RADIO—FIRST IN TELEVISION

McGEE'S 20TH ANNIVERSARY SALE IS NOW ON—LOOK TO McGEE FOR VALUES

NEW 1951 MODEL 12-INCH "COAXIAL" SPEAKER!



- WIDE RANGE RESPONSE—40 to 17,500 CPS.
- ONLY 2 WIRES TO CONNECT TO ANY AMP OR RADIO
- NEW HEAVY DUTY CONSTRUCTION

"WHY PAY MORE?"

SALE PRICE **$12.95**

Model CU-14X

McGee announces our new 1951 model 12-inch coaxial speaker, designed for the critical music listener; for use with high fidelity audio systems and radios. This new model reproduces all music and voice with a natural quality. It is improved over our last model in that the 12" woofer now has a heavy duty 31 oz. Alnico 5 magnet. This reproduces the lower musical register down to 40 cycles. The coaxially suspended tweeter has a specially designed cone for the higher register of music and voice. It will respond up to 17,500 CPS. The high pass filter is attached and combined impedance will hook up to any 8 ohm output transformer. It will connect in place of any ordinary speaker only two wires to connect. Why pay $20 to $40 for a speaker? McGee has them made to their own specifications, by the thousands and passes the savings on to you. We have sold over 10,000 coaxial speakers. Why pay more than McGee's price? McGee's 12", 20 watt wide range coaxial PM speaker, Model CU-14X. Net price, **$12.95**; 2 for **$25.00**. Shipping weight 10 lbs.

NEW 1951 MODEL 15" "COAXIAL" PM SPEAKER

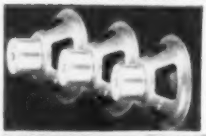
20TH ANNIVERSARY SALE PRICE

$17.95

Model P15-9

McGee's new 1951 Model 15" coaxial PM speaker is here! And at a price everyone can afford, **$17.95**. This speaker is ideal for all types of radio and audio amplifier use. It may be connected to any 8 ohm output transformer. The 15" woofer has a 32 oz. Alnico 5 magnet and the coaxially suspended 5" speaker has its own magnet and voice coil. A true coaxially built speaker. The high pass filter prevents low frequency notes from reaching the tweeter. The response of this 15" coaxial is from below 20 CPS to above 17,500 CPS. It is the best speaker value in the U.S. today. We buy these by the carload and pass our savings on to you. If you have or are building one of our high fidelity amplifier kits, this speaker is the one you should have. It is a tremendous value. Why pay more than McGee's price, for a 15" coaxial PM speaker? Stock No. P15-9. Shipping weight 14 lbs. 20th Anniversary sale price **$17.95** each, 2 for **$34.00**.

SUPER HEAVY DUTY 10" PM $4.95



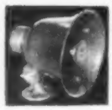
We made a special purchase on several hundred 20 watt, 10", 32 oz. Alnico 5 magnet PM speakers. Deep throat and nose nesting cone. Ideal for all high fidelity sound systems and radio replacement. The magnet on this speaker is usually used on a 15" size. Very efficient, good high and bass response. You'll appreciate it when you get your hands on this speaker. Attractive copper finish. 8 ohm voice coil. Stock No. 1025PS. Weight 7 lbs. Net price **$4.95** each.

Order three of these and use them in a cluster of three. They will take 60 watts of audio and have more cone area than any 15" speaker. For high power, top quality P.A. work. Think this over. 3 No. 1025PS speakers for only **$13.95**.

REG. $54.00 LIST 25 WATT DRIVER AND TRUMPET $23.95

This trumpet and driver is especially designed for all outdoor speaker uses; churches, sound trucks, etc. It is the most popular size sold today. McGee offers you more for your money. Each speaker is fully guaranteed. Model XX-100, all weather proof 3½ foot trumpet, made of aluminum castings and spinnings. 10" bell trumpet can be used with any standard driver. Regular **$29.00** list. Ship. weight 15 lbs. Net price **$13.50**. Model RM-30, standard 15 ohm, 25 watt driver for use with above trumpet. Quality second to none. Shipping weight 6 lbs. Net **$12.50**. Combination offer. Buy the XX-100 trumpet and RM-30 25 watt driver, both for **$23.95**.

10 WATT PAGING SPEAKER $11.95



Model 10-XXP, 10 watt paging speaker with built-in weatherproof driver. Spun aluminum construction, 8 ohm voice coil. Regular net on this speaker is over $15.00. A special purchase by McGee makes this **$11.95** price possible. Shipping weight 4 lbs.

HIGH FIDELITY OUTPUT TRANS. 20 20,000 CPS

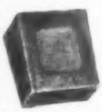
Only $6.95

BEST VALUE IN U.S.A.

A-403—6600 ohms. Plate to Plate.

Why pay $20.00 or $30.00 for an output? Supreme quality and high fidelity output transformer. Designed to match push-pull plates 2-6L6, 2-6V6, or 2-6AQ5 class AB, to 4-8-15-250 and 500 ohms with 10% feedback winding. Housed in a compound filled case, 3½x4½x4½". Actual net weight 6 lbs. If you want the best quality from your audio system, order this transformer. Response essentially flat from 20 to 20,000 cycles. We have tried several high fidelity outputs in our lab and find this to be the best value. Even though your amplifier only puts out 10 or 15 watts, this 34 watt job is what you should have. Connecting instructions are furnished. Stock No. A-403, shipping weight 8 lbs. Net price....**$6.95**

10" HEAVY DUTY P.M. WITH BAFFLE



RED HOT SPECIAL

$7.49

Super heavy duty 10" 32 oz. Alnico 5 PM speaker, with 8 ohm voice coil. Ideal for music box operators and all sound installations. A lucky purchase makes this unusual value possible. The baffle is of the conventional slanting wall type mounting, made of plywood and covered with leatherette. Stock No. SP-10. Net price **$7.49** each. In lots of 3 or more, **$7.00** each.

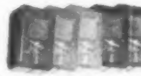
20TH ANNIVERSARY INTERCOM SALE!

$25,000 WORTH OF INTERCOMS AT SCOOP PRICES

5-STATION INTERCOM MASTER

MASTER STATION **$14.95**

SUB STATION **$3.95** EACH

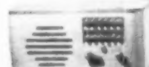


5 station intercom master station, in an attractive walnut cabinet, 10x5½x6". 5 pushbuttons, you can call any one or more substations. Talk-listen switch has a silent position. Volume control on front panel for easy access. The amplifier is of the conventional AC-DC design, with plenty of power. Equipped with a full size Alnico V PM speaker. This intercom master is new 1950 production by a well known factory. Made to sell at a much higher price. Only 300 to sell at the special purchase price of **$14.95** each. 5 station intercom master No. 2700. Weight 7 lbs. Net price **$14.95**.

Intercom master, same as above, except in addition to the 5 station switch a 6th pushbutton is added to call all stations at once. Stock No. 2701. Net price **$16.95** each.

Molded walnut plastic substations for use with Model 2700 Master. Full size Alnico V magnet PM speaker, spring return call-back switch, size 5½x4½x3½". Shipping weight 2 lbs. each. Mounts either on the wall or may be set on desk top. Very attractive. Net price **$3.95** each. **5 for $18.95**. 3-wire plastic intercom cable, 100 ft. **$1.50**, 500 ft. **$7.50**, 1000 ft. **$12.60**.

10-STATION A.C. MASTER STATION $24.95



- Powerful—6V6 Output Tube
- Walnut Vernier Cabinet
- Push Button Selector
- Sub Stations $3.95 Each

Super heavy duty, 10 station intercom master, designed for continuous service. A powerful AC transformer type with 80 rectifier, 6V6 output and 6SJ7 driver, 5" speaker with 2.15 oz. Alnico V magnet. Housed in a walnut cabinet 14" long, 6½" deep and 7½" high. Designed to install as a 3 wire system. 10 push button station selector on front, with separate all station call switch. Talk-listen switch has silent position. Made to sell for a much higher price. McGee made a fortunate purchase and passes the bargain on to you. Shipping weight 12 lbs. Stock No. 2520. Net **$24.95** each.

We have a few Model 2520. Built for Master to Master use. Price on Master to Master **$25.95**.

Attractive walnut plastic cabinet, sub station for use with the model 2520 master. Has lever acting call back switch and Alnico V PM speaker. Net price **$3.95** each. 10 for **$37.50**. 3 conductor plastic intercom cable, **$1.50** per 100 ft. 500 ft. **$7.50**, 1000 ft. **$12.60**.

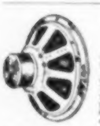
Our Leader Changer Scoop $10.95, 2 for $20.90

Our leader, automatic changer scoop. Base size 13x13". Plays 10 12" or 12 10" 78 RPM records automatically. Has Astatic L-70 cartridge. Priced complete with a metal base, which can be used in slide away compartment or as a table top base, or changer can be lifted off base to fit your needs. Stock No. AD-12. Shipping weight 17 lbs. Scoop price **$10.95** each.

1950 MODEL TAPE RECORDER $79.95

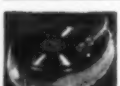
Our brand new 1950 model portable tape recorder. Response, 80 to 8,000 CPS. With this you make and play-back top quality tape recordings. Tape speed, 7½ in. per second. New portable records 1 hour on 1200 ft. reel of tape. Fast rewind. Record 30 minutes, turn spool over and record second 30 minutes on 1200 ft. reel. Has an AC transformer type amplifier with 6" speaker. Inputs for mike and radio. External speaker jack. Price includes 30 minute reel of tape and mike. Hinged lid is removable. Case is attractive leatherette covered. Size 10x12x14". Shipping weight 29 lbs. Stock No. PLT-1. Net price **$79.95**.

MODEL CN-1232 12 INCH 25 WATT PM $5.95



Another McGee red hot special 12" 32 oz. Alnico 2-3 ring magnet PM. 8 ohm voice coil speaker. Made by Consolidated. A regular **$17.00** list. Shipping weight 8 lbs. Model CN-1232. Net price **$5.95** each, 4 for **$22.00**.

78 R.P.M. RECORD PLAYER $11.95



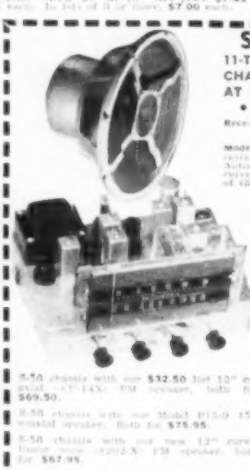
Self-Contained Amplifier and Speaker. Here is a red hot value. A complete self-contained 78 rpm record player with its own amplifier built in. It has a 1.5 oz. Alnico V PM speaker. Extra heavy duty 78 rpm phono motor. The amp and speaker are concealed under the attractive plastic base. This is a complete built-in player and has better tone and more power than you would expect for a player of its size. Only 300 to sell. Stock No. P-100P. Sale price, **$11.95**.

G.E. RECORD PLAYER ATTACHMENTS

SALE PRICE **$6.95**

General Elec. 78 RPM Record Players to attach to any radio or amplifier. Heavy duty motor and standard crystal phono pick-up. Volume control and off-on switch. Ship. weight 8 lbs. (No pre-amp necessary.) 78 RPM Model. Stock No. GE-78, **$6.95**. 33⅓ RPM Model. Stock No. GE-33 has Webster crystal pick-up with needle. Net, **$6.95**. Buy 3 for **$19.50**.

S-56 HALLICRAFTERS



11-TUBE FM-AM CUSTOM CHASSIS. A $110.00 VALUE AT McGEE FOR ONLY . . .

$59.95

- WIDE RANGE • AUTOMATIC FREQUENCY CONTROL ON F.M.

Receives 88 to 108 MC F.M. and Broadcast 550 to 1650 K.C.

Fine for Custom Installation

Model S-56 Hallicrafters. 11 tube AM-FM radio receiver chassis for broadcast and FM 88 to 108 mc. Automatic frequency control on FM, holds the receiver in perfect tune. Phono connection on rear of chassis. Full range tone control with bass boost. Push-pull 6K6 tubes in audio system. Frequency response essentially flat, from 50 to 14,000 CPS. Wide vision, accurately calibrated slide rule dial, with pre-selection on broadcast band. Output transformer matches any 8 ohm speaker. 4 antenna terminals, two for AM and two for FM. This is the finest type of home radio that we know of today. Better get your order in early. Designed to be used in commercial radio selling in the $400 to $800 class. The regular dealers' net on this chassis is $110.00. However, a lucky purchase enables us to offer these brand new, factory cartoned S-56 Hallicrafters chassis, complete with tubes and operating instructions, at only **$59.95** less speaker. Chassis size 12¾x10x7¼". Weight 25 lbs. Brand new factory cartoned. Buy your S-56 with a wide range PM speaker.

S-56 chassis with our **$32.50** list 12" coaxial (CU-14X) PM speaker, both for **$69.50**.

S-56 chassis with our Model P15-9 15" coaxial speaker. Both for **$75.95**.

S-56 chassis with our new 12" curvilinear cone (1202-X) PM speaker, both for **$67.95**.

VM-950 Tri-O-Matic, 3 speed changer **$28.35**.

VM-950-GE, 3 speed changer with new GE RPX-050 V.R. cartridge **$31.27**.

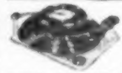
Pre-amplifier for S-56 $3.95

Dual purpose preamplifier for either S-56. Only 4 wires to connect (instructions furnished). With this you can convert set to operate either a G.E. variable reluctance pick-up or a crystal or dynamic mike, making your S-56 a home P.A. system. Preamp Model SS-PA. Size 3½x4x3". Shipping weight 2 lbs. Net price, **$3.95**. Crystal mike and desk stand, **$4.95** extra.

Recording Tape Sale

McGee's 20th Anniversary sale of magnetic recording tape. Top quality second to none. Why pay more? All plastic base, red oxide coated on plastic reels. 1 hour spool 1200 feet. Net **$3.30** per reel. 30 minute, 500 feet. Net **$2.10** per reel.

V.M. 3 SPEED Record Changers



VM Model 406 deluxe 3 speed automatic record changer—plays them all—intermixes records of the same speed—equipped with a flip over crystal pickup with twin needles—a very sleek designed record changer—base size 12¾x13. Ship. weight 12 lbs. VM-406. Net **$33.21**.

Buy the VM-950 changer with or without base. Choice of G.E. VR or crystal cartridge. We think the VM-950 record changer is the finest in America. It automatically plays all records all speeds and all sizes; 12 10-in., 33⅓ or 78 rpm. 10 12-in., 33⅓ or 78 rpm and 12 and 10-in. records of the same speed intermixed, 12 7-in. 33⅓ or 12 7-in. 45 rpm. Automatically shuts off after the last record. Size 13 13/16x11⅞x7¼ in. high. Offered with crystal cartridge, G.E. VR cartridge, or either with a base. VM-950, 3 speed changer with standard output crystal cartridge and needles for 1 and 3 mil. (78 rpm, 33⅓, 45 rpm.) Net **$28.35**.

VM-950GE, 3 speed changer with the new RPX-050 magic button, all-in-one variable reluctance cartridge with stylus. Net **$31.27**.

VM-955, 3 speed changer with crystal cartridge on a base. Net **$31.53**.

VM-955GE, 3 speed changer with RPX-050 VR cartridge and stylus; with base. Net **$33.59**.

McGEE RADIO COMPANY Prices F.O.B. K.C. Send 25% Deposit with Order, Balance Sent C.O.D. With Parcel Post Orders, Include Postage. TELEPHONE VICTOR 9045. WRITE FOR FLYER 1422 GRAND AVE., KANSAS CITY, MISSOURI

BUILD A HI-FIDELITY AMPLIFIER WITH A McGEE KIT

COMPLETE 5-TUBE A.C. SELF-POWERED BROADCAST TUNER KIT

USE WITH ANY AMPLIFIER

$11.95

A self powered, 3 gang superhet tuner kit, with R.F. stage. When wired according to our diagram will make the best possible broadcast tuner, (550 to 1650kc) for use with any amplifier. Has a 6" lighted slide rule dial. Don't class this with ordinary tuners, this has its own transformer. The complete kit is furnished with a diagram and photo, with tubes: 6SK7 R.F., 6SA7 converter, 6SK7 I.F., 6H6 detector, 6x4 rectifier. Connect to any audio amplifier. Ideal for use with our XK-34, TM-15 or our 20-20 amp. kits. Chassis size: 9¼x8¾x4½" high. Shipping weight 8 lbs. Broadcast tuner kit, Model BT-38. Net price $11.95.

A Complete Kit with Tubes and Diagram

COMPLETE 18-WATT WIDE RANGE AMPLIFIER KIT

RESPONSE 20 TO 20,000 CPS.

INPUTS FOR—RADIO TUNER—MIKE AND RECORD PLAYER

$19.95

This kit, when wired, will make a 20 to 20,000 CPS, wide range, all purpose, 18 watt music appreciation amplifier. Inputs for a radio tuner, crystal or dynamic mike and crystal phono pickup. Also has preamplified for GE var side reluctance pickup. Nothing but the finest quality material is furnished with this kit. Heavy 20 watt power transformer, punched with ample tapped primary and secondary windings to match 4, 8 or 16 ohm PM speaker. Chassis size, 17x9x4" high. Tube lineup is 5-6SJ7 and 2-6L6 tubes. Uses a new type of variable reluctance pickup, which has a very low resistance. Has well rated power output, separate tone and treble boost controls and fader control. Designed with all the features found in amplifiers costing much more. Response is flat from 20 to 20,000 cps. Complete with tubes, less speaker. Model I-2020. Shipping weight 16 lbs. Net price $19.95. Optional mike and desk stand $4.95 extra.

BROADCAST QUALITY TRANSFORMER KIT

Response 18 to 22000 C.P.S. The Same Quality as Used in the Finest Quality Audio Amplifiers

Why Pay More **Sale Price $11.95** THIS MONTH ONLY

Here is the hottest transformer kit we have ever offered. Originally intended for use in the high priced Leaf recorder amplifier. Made of the best possible material to give broadcast station frequency response: 18 to 22,000 CPS. A suggested diagram is furnished to build an amplifier with inputs for G.E. variable reluctance phono pickup, crystal phono pickup or radio tuner. Here are the transformer specifications: The output is a compound filled case, 3 x 2½ x 3½" high, weight 2¼ lbs. response 18 to 22,000 CPS. Impedance 2-6V.C.T. push-pull 12 watts, match 8 ohm speaker. The power transformer is a fully shielded upright model, 3½ x 4½ x 4½" high, weight 4¼ lbs. Primary is universal 0, 105, 117, 210, 230 volts. Rectifier bridge, easy to hook up, full details included, which delivers 300 volts at 200 mils. On the low voltage secondary, also has a 6.3 volt 5 amp. filament winding. The selenium rectifiers come with the kit. The choke is a 10 henry 200 mil unit the same size as the output. You get full description of the kit, including a suggested schematic. You order the parts separately. We furnish the power transformer, choke, output and rectifiers, shipping weight 15 lbs.

Stock No. TS-1, Net price $11.95

8-TUBE—ALL TRIODE-HI-FIDELITY

20-WATT AMPLIFIER KIT MODEL TES 29.95

CONTROLS—ON CHASSIS OR EXTENSION LEADS

A newly designed all triode amplifier kit, with separate tone and treble electronic tone controls. Has extremely flat frequency response from 20 to 20,000 CPS. Inputs for a radio tuner, crystal or variable reluctance phono pickup and crystal or dynamic mike. Has 20 watts output. Controls may be mounted on the chassis, or on extension leads, as you prefer. Only the amplifier is need by our specialists. All parts need to complete, including diagram, super high fidelity shielded output transformer, which delivers any 4, 8 or 16 ohm PM speaker. Power transformer is fully shielded and rated at 300 mils. Has 5 volt 4 amp. filament winding for the 5V4G rectifier. This is one of the finest amplifier kit as we have ever made. Will give 20 watts output. Tubes furnished: 2-6SL7, 2-6V6, 2 Western Electric tubes VT-52 or 6A5. Stock No. TES, kit complete. Net price $29.95

$19.95 BUYS A NEW St. George Wire Recording Mechanism

ONLY 200 TO SELL

McGee offers you at a terrific saving the St. George Series 1100, wire recording mechanism. Brand new and factory guaranteed. Records and playbacks from a standard recording wire, up to 1 hour. The wire takes off from one 7½ inch spool, and winds on the second spool. Records at 7½ inches per second. Has a 4 inch speaker, for playback. Has a phono jack for connecting to a phono amplifier, if required. (m13x315)". Shipped with a diagram of how to connect and also how to wire to any of the low output radio or phono amplifier to be used in connection with any recorder to be used in connection with any recording mechanism. Series 1100 shipping weight 25 lbs. Net price $19.95

Crystal phono pickup, same as worldwide $1.95 extra. Recording wire, 15 minute reel, 1000 feet spool. Net price $1.19

Needle cleaner. Net price ..... $1.79. 1 hour speed. Net price ..... $2.79. Crystal mike and desk stand $4.95 extra.

1 or 4 VOLT CRYSTAL CARTRIDGES $1.99

McGee offers you a famous make crystal cartridge, standard size and shape, but very high output. Will track on any 1 to 4 oz. pressure. Uses A-6, 1.25 mil needle, replaces Astatic G-1D, 1 volt output, replaces Astatic T-12. Net price ..... $1.99. Net $1.99. Buy 10 assorted for $19.00.

100 KNOBS Set-Screw Type 3.95

100 bakelite set screw knobs, for radio set replacement. All 6t standard ¼" shaft. Assorted in pointer, skirted and flat. Total of each style in one hundred sets. This value worth $7.50. Shipping weight 5 lbs. Deal No. RN-10K, 100 knobs. Net $3.95.

SELENIUM RECTIFIERS

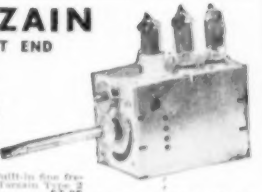
65 Mil Selenium Rectifier	49c
75 Mil Selenium Rectifier	59c
100 Mil Selenium Rectifier	59c
150 Mil Selenium Rectifier	75c
200 Mil Selenium Rectifier	99c
250 Mil Selenium Rectifier	$1.09

Mc Gee's XX quality selenium rectifiers, small size, compact construction. All 1930 production. Guaranteed No. 1 factory fresh, but unboxed, quality. Fully guaranteed. 130 volt RMS rated.

SARKES-TARZAIN

13-CHANNEL T.V. FRONT END

WITH TUBES AND DIAGRAM $7.95



This popular Sarkes-Tarzain television front end is widely used today. The 13 channel rotary switch type with turret contacts and coils. Price includes a schematic diagram and 3 tubes, 6J6 and 2-6AG7. Shipping weight 2 lbs. Regular factory cost is twice our price. Order tuner and the two tube sockets are wired, ready to hook up to a set. Has built-in sound IF strip. May be used with either intercarrier or separate sound IF circuits. Built-in fine frequency control, this, weight 3 lbs. Sarkes-Tarzain Type 2 TV tuner with tubes $9.95

Combination deal Sarkes-Tarzain TV tuner and 205-SX video coil kit both for $14.95

Sarkes-Tarzain Type 2-Same as Type 2 only has input IF coil built-in. Tapped for sound IF channel. Net $9.95

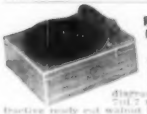
Sarkes-Tarzain Type 2 tuner and 205-SX coil kit both for $16.95

10 OZ4 TUBES 10 4-PRONG VIBRATORS ALL FOR $16.95

RED HOT SPECIAL

Here's a red hot deal for you fellows that need a few tubes and vibrators. 10 standard brand metal 6Q4 tubes and 10 of our latest improved 4-prong vibrators. The tube is of the finest design for TV use, standard diameter can, short enough to fit all TV chassis. The vibrators are our latest 4-prong. Our 20th Anniversary, big deal No. RN-20. Total shipping weight 5 lbs. 10 6Q4 tubes and 10 4-prong vibrators, all for $16.95. Shipping weight 5 lbs.

RECORD PLAYER KIT $9.95



Complete record player kit for 7" to 10" records. All parts, tubes and diagram for building a 5 or 7 tube amplifier. Attractive ready cut walnut veneer cabinet to fit. Ballentine phono motor and turntable with permanent needle. Has separate mike mixing control. Model No. MD-15. Net price $9.95.

Crystal cartridge model No. D-3378, same as above only has 3 speed model and by weight crystal pick up for all 331/3 and 78 speed needle. Net price $13.95.

Picture TUBES

16" 16JP4	$19.95
12½" 12LP4	$14.95

Number one quality television picture tubes. Guaranteed to be perfect quality for 90 days. Best quality, with neutral or white face. Factory design with new type of focusing proximity. Will give more than McGee's price; only 500 left to sell. Don't confuse these 12 and 16 inches with those when they are price. 16" tube, weight 18 lbs. Shipping weight 150 lbs. Deal No. 16-1. 12" tube, weight 12 lbs. Shipping weight 100 lbs. Deal No. 12-1. Because most of the glass tube bowls are flat, guaranteed not to implode. Will be factory perfect, but while 50 last. Net price $14.95 each. 12LP4 and 16JP4 are identical, except 12LP4 is rectangular, but give perfect picture. Net price $11.95.

TELEVISION VIDEO COIL KIT— 20 MATCHED COILS FOR PICTURE AND SEPARATE SOUND I.F.

Order with a Sarkes-Tarzain Front End for $14.95

$7.95

20 matched TV coils, video and sound I.F. McGee heavy duty, factory made video coil kit, for TV sets up to 16", using separate sound and picture circuits. Has 4 peaking coils, 2 video I.F. transformers, 3 video and 22 tube TV circuit. All coils are of the finest construction, furnished to you ready to use. Each coil is shielded and tested. Has 2 to 3 mc bandpass. Kit has a top quality coil complete for 21" TV set. Although only 205-SX, shipping weight 5 lbs. McGee's price $7.95.

Coil kit has 1-180 oh, 1-220 oh, 2-120 oh, 2-93 oh speaking coils, 4 picture IF coils for 21" TV set, although only 205-SX, shipping weight 5 lbs. McGee's price $7.95.

BRAND NEW GENERAL INST. TELEVISION FRONT END-TUNERS

Sale Price **$7.95**

A special purchase of brand new G.I. television tuners, makers of 16", have replaced with latest G.I. tuners in their new 16" sets. Has 6 tubes, 3 dual purpose, 1 G.I. tuner, 1 G.I. selenium rectifier, 1 G.I. 6" speaker. Has 4 mc bandpass, will receive all 13 channels. Complete with tubes, less cabinet $20.00

A fortunate purchase from a T.V. set manufacturer, who has a large sales possible RCA 13 channel tuners, completely assembled, ready to hook up to any set. Has 6 tubes, 3 dual purpose, 1 RCA 13 channel selector tuner, 1 RCA 13 channel oscillator tuner, 1 RCA 13 channel mixer tuner. Has 4 mc bandpass, will receive all 13 channels. Complete with tubes, less cabinet $7.95

Brand new tuner, has 4 mc bandpass, will receive all 13 channels. Complete with tubes, less cabinet $14.95

Brand new tuner, has 4 mc bandpass, will receive all 13 channels. Complete with tubes, less cabinet $14.95

BRAND NEW R. C. A. TELEVISION FRONT END-TUNERS

Sale Price **$14.95**

A fortunate purchase from a T.V. set manufacturer, who has a large sales possible RCA 13 channel tuners, completely assembled, ready to hook up to any set. Has 6 tubes, 3 dual purpose, 1 RCA 13 channel selector tuner, 1 RCA 13 channel oscillator tuner, 1 RCA 13 channel mixer tuner. Has 4 mc bandpass, will receive all 13 channels. Complete with tubes, less cabinet $14.95

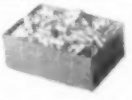
Brand new tuner, has 4 mc bandpass, will receive all 13 channels. Complete with tubes, less cabinet $14.95

Brand new tuner, has 4 mc bandpass, will receive all 13 channels. Complete with tubes, less cabinet $27.95

100 MOLDED PLASTIC BYPASSES $8.95

100 molded plastic tubular by-pass condensers. All 600 volt. And all by the same nationally known mfgr. Regular dealer net cost is over $8.00. Special for our 20th Anniversary sale price. You'll chuckle when you look these over. Here's what you get: 10-.0001, 10-.0002, 10-.0005, 20-.001, 20-.01, 20-.02, 10-.05 and 10-.1, for the big deal No. RN-20M. 100 molded plastic tubulars, shipping weight 2 lbs. Net price $8.95.

100 TOP QUALITY 600 VOLT TUBULARS $5.95



100 top quality 600 volt tubular by-pass condensers. Made this year in a famous condenser factory. Don't confuse these with grab bag samples. Mcgee's deals are guaranteed to please you. Here's what you get: 10-.001, 10-.002, 20-.005, 20-.01, 10-.02, 20-.05 and 10-.1 600 volt condensers. Our big deal No. RN-20S. Shipping weight 2 lbs. Net price $5.95.

REG. $20.58 MASCO T.V. BOOSTER FOR $13.39

Masco MTB-13X, 13 channel television booster. A regular $20.58 dollars net item, on sale at McGee for only $13.39. Brand in an attractive walnut cabinet, 11¼x7x6¼", fully powered, operates on 110 volts AC. Fitted complete with 2-6AK5 tubes. These boosters are brand new and factory cartoned. Shipping weight 4 lbs. Mcgee's sale price only $13.39 each. Two for $25.00. The price is good only as long as our supply lasts.

20 SELENIUM RECTIFIERS $9.95

Re Prepared for Best for Shortages

20 top quality selenium rectifiers. Guaranteed good as new. Latest compact construction. All standard 110 volt. Use these for price AC-DC sets when tubes are hard to get. 10-65 mil and 10-130 mil selenium rectifiers. McGee's big deal No. RN-20R. Shipping weight 2 lbs. Net price $9.95.

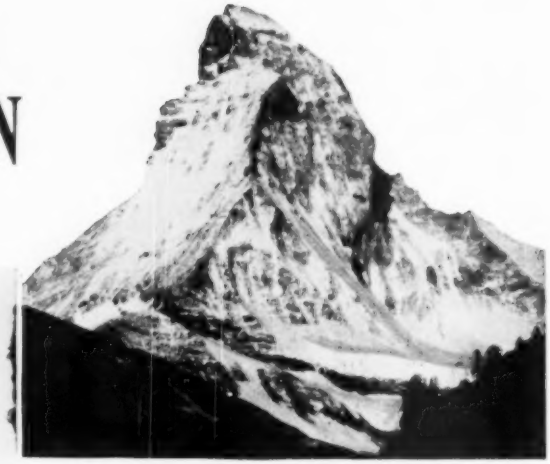
McGEE RADIO COMPANY Prices F.O.B. K.C. Send 25% Deposit with Order. Balance Sent C.O.D. With Parcel Post Orders, Include Postage

TELEPHONE VICTOR 9045. WRITE FOR FLYER 1422 GRAND AVE., KANSAS CITY, MISSOURI

The MIKE On MATTERHORN

By
KENNETH J. HENDERSON
Swiss Shortwave Service, Berne

Broadcasting from a precarious foothold on the way up. Center, John Lamb looks over his notes while Edouard Merinat (top, left) gets in transceiver communication with the base as the guide holds the antenna mast. Below the mast is the tiny transmitter.



Matterhorn, scene of the unique broadcast described in this article. Directly in front of photograph is the N.E. arrête up which the broadcasting party climbed this 15,000 foot peak.

The "inside story" of a history-making event, unique in the annals of radio.

SHORT-WAVE enthusiasts throughout the world were privileged to hear a unique broadcast early in August when the *Swiss Broadcasting Corporation* scheduled a transmission from Matterhorn, 15,000 foot giant in southern Switzerland.

Long dreamed of by Swiss radio men, the stupendous feat was made possible by the use of modern ultra short-wave transmitting apparatus, much of it especially designed and constructed for the broadcast. Marcel Chasset, HB9FE of Fribourg, Switzerland, assembled two 6C4 units which measured 15.6 cm. square (approximately $6\frac{3}{16}$" square) and 15 cm. deep (approximately 6"). Input was 2 watts and the tubes were plate modulated. The crystal microphone amplifier was an A/W 16-A G5 and a 6AK6 tube was used as a modulator. The whole unit weighed 2.900 kilograms (about $6\frac{1}{4}$ pounds) and was powered by two 120 volt storage batteries coupled in series. Filament power was supplied by a 6 volt storage battery of the M/C type.

Chasset was faced with a tough problem since the apparatus had to be light enough to carry at high altitudes, tough enough to stand up under the physical shocks it would receive during the gruelling climb, and finally, well enough constructed to withstand sudden and extreme changes in temperature and pressure. In addition to these requirements the equipment had to provide broadcast quality over a distance of six kilometers (about 4 miles).

The folded dipole antenna, designed for use with the transmitters, consisted of three pieces—the masts were made of two plastic tubes which screwed into each other while the crosspiece was of light wood, hinged in the middle so that it could be stowed in the haversacks. The feedline was a 300 ohm *Amphenol* cable with the lead just long enough to reach the transmitters at the foot of the masts. All material carried by the climbing party was duplicated in case of failure. Total weight was 130 pounds.

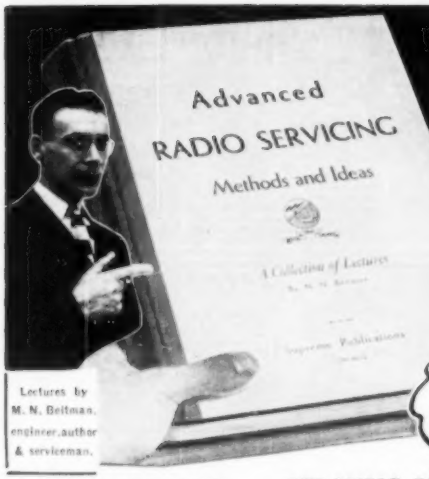
The receiving antenna was a three-element, close-spaced rotary beam. This unit was tied to the chimney of the Hotel Beau-Site in Zermatt, where a temporary studio and recording center had been set up in the hotel tower. The tower commanded a clear view over the entire route followed by the party from the base of its climb—the Hornli Hut at 9500 feet.

With nearly a week to go before the scheduled Sunday broadcasts, we felt confident. Then a small, thin cloud—dangerous in this region—appeared in the sky and for the next four days we sat through showers. Snow, turning to treacherous ice, fell at as low an altitude as 6000 feet. Thursday, the day set for the trials under actual climbing conditions, was so bad the party could get no farther than the Hornli Hut.

Finally, on Saturday the weather cleared and with the promise of 48 hours of clear weather the ascent began. From point-to-point, the climbers gave us a detailed description, direct from the sheer slopes of the Matterhorn while they were tied uncomfortably on fixed ropes to the sheer 200 foot wall not far from the summit. All of the transmissions were clear as a bell—except from one of the huts when the other alpinists passing along the narrow ledge interrupted the field of the antenna.

The Swiss National Anthem, played on a harmonica by one of the guides, from the 15,000 foot top of Matterhorn fulfilled and climaxed a long-dreamed of achievement for *Swiss Broadcasting Corporation*. Today, used-up batteries remain on the peak as souvenirs of a climb unique in alpinism and radio broadcasting.

—30—



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Add years of valuable experience to your radio knowledge by using ideas and tricks of an expert. Use this new 3-in-1 giant-size 30-lecture manual to polish up your radio servicing ability, so that toughest jobs will be as easy as replacing a filter condenser. Learn the cause of every puzzling radio defect. Use Beitman's 19 years of successful radio experience to your own advantage.

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Think what it would cost to attend in person the 30 lectures completely printed in ADVANCED RADIO SERVICING manual. Perhaps $60, plus carfare. But in this mammoth volume you have every word of all lectures, illustrations of every slide used, and many additional photographs and charts. The special bargain price for the complete 30-lectures in the giant manual is only $3, postpaid, full price, nothing else to pay. Send coupon at bottom of page to try this material for 10 days without risk under our guarantee.

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By simply reading these 30 lectures and examining the hundreds of interesting illustrations, slides, and diagrams, you add 19 years to your own radio experience. This is real practical knowledge to place you above competition. Facts to help you improve your shop, how to obtain free advertising. Learn what faults are most common to various circuits, how to find these faults quickly, and what instruments to use. Material on every important radio servicing topic including F.M. and TV. See column at right. Send coupon at bottom of page.

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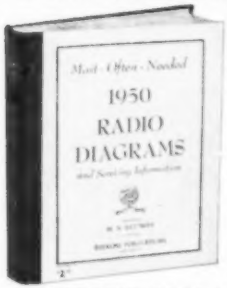

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Now you can benefit and save money with **Supreme** amazing scoop of 1950. This one giant volume has all the service data you need on all recent radio sets. Here you have clearly-printed large schematics, needed alignment data, parts lists, voltage values, and information on stage gain, location of trimmers, and dial stringing illustrations. This is the help you need to find tough faults in a jiffy. The new 1950 radio manual is a worthy companion to the 9 previous volumes used to an advantage by over 120,000 shrewd radio men.

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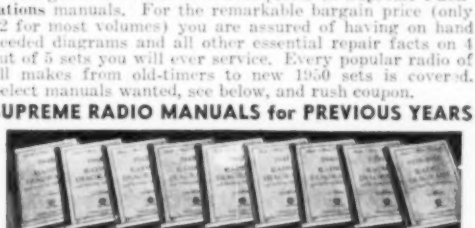

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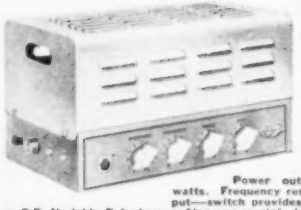

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Inputs for Crystal Mike, Variable Reluctance and Crystal Pickup. Olson's Great Bargain.

It's unbelievable, but Olson has done it again. A full 12 watt beautifully built 5 tube amplifier which has inputs for crystal microphone, variable reluctance phono pickup and crystal phono pickup. In addition this amplifier is equipped with dual tone controls for treble and bass boost, equalized circuits and hum-free wide range response. Engineered by one of the foremost sound experts in the country and licensed by Western Electric. Guaranteed to satisfy. **OLSON'S BARGAIN PRICE**

Power output—12 watts. Peak output—17 watts. Frequency response 7-20,000, 40 to 15,000 CPS. Input—switch provides choice of conventional crystal pickup or G.E. Variable Reluctance. Also any crystal, dynamic or ribbon mike. Also any radio tuner. Controls—1 phono or Radio tuner; 1 Mike; 2 bass and treble tone controls. Tubes—2—6SL7gt, 2—6V6gt, 1—5Y3gt. Output impedances—4 and 8 ohms. Voltage—105-125 volts AC, 60 cy. Complete with tubes

$29.95 RA-38

FREE—SEND FOR OUR LATEST RADIO AND TELEVISION BARGAIN CATALOG

30 WATT AMPLIFIER
- Factory Built
- Latest Design

Olson's Price less tubes. RA-23 ..... **$34.95**

A real commercial amplifier which looks good and performs well. Not a kit task, mike 150DB, phono 60DB. Has dual tone control, one for bass and the other for treble tone, output impedances 4, 8, 15 and 500 ohms. Has three mikes and one crystal pickup. Ship. wt. 50 lbs. Tubes required, 3—6SQ7, 1—6X5, 2—6L6g, 1—5V4g.

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World's Fastest Automatic Changer for RCA 45 R.P.M. Records

RA-45 **$8.95** Each

Price Slashed by OLSON

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AM-FM RADIO CHASSIS
Olson Bargain of the Year

Stock No. RA-52 with tubes, only **$49.95**

It's new! Never offered before by any jobber! A high quality, high-fidelity radio that you will be proud to own. You'd expect to pay more but Olson made a remarkable deal with the manufacturer. When present stock is gone, there will be no more. This receiver can be used in combinations selling from $350.00 to $500.00. It's a perfect unit for custom building cabinets, shelves, etc. This amazing set is equipped to receive standard broadcasts from 540 to 1640 KC and FM reception from 87.5 to 105.9 mc. Two dial controls are provided for simplicity of operation.

Phono connection on rear of chassis. Wide vision, easy to read dial. This radio cannot be beat for quality and precision.

Any FM speaker can be used with this set. Choose one from this flyer. Set is supplied with 8 tubes: 1—12AT7, 1—6BH6, 2—6BA6, 1—6AL5, 1—6AV6, 1—6V6GT, 1—5Y3GT, less speaker. Individually packed in factory sealed cartons. Chassis size 13¼"x7-1/16"x8⅞".

Insulated Resistor Kit

Contains a carefully selected assortment of 100 insulated resistors. Standard RMA color code. Included are 70—½ watt, 20—1 watt and 10—2 watt resistors. Handsomely packed in a durable plastic bag. Regular list price $15.80.

$3.99 AS-32

MICA COND. KIT AS-18 **98c**

Contains an assortment of 10 Mica condensers. Priced at less than half. Ideal for experimenters. Special purpose kit. SPECIAL AT OLSONS

BY-PASS COND. KIT **$1.59** AS-35

Assortment of 50 popular values, 200 to 1700 volts, capacities from .0002 to .25 mfd. Quantity limited; stock up now at this terrific bargain price. Shpg. wt. 3 lbs. OLSON'S BARGAIN.

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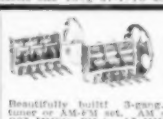

MATCHED PAIR AM-FM CONDENSERS

Beautifully built 3-gang. Build a tuner or AM-FM set. AM sections are 365 MMFD, FM is 15 MMFD per section. Can be operated by push-button. Has Cen. Gnd. Shaft 3/8" dia. Condenser 2"x 1½"x3". Shpg. wt. 3 lbs.

X-201. Only at OLSON'S. **69¢** Pair

X-158 **22c**

H & H TOGGLE SWITCH

Heavy duty, 15 amps, 125 V. AC. Brass toggle, single throw, single pole.

KIT OF THREE VARIABLE CONDENSERS

A $3.50 value. Perfect for the experimenter. Brand new stock. Quantity limited.

Get a kit containing 3 assorted Sealtite condensers. Popular values. 2-gang and 1-gang. Some have trimmers, vernier drives, AM and FM styles. Olson's Price **$1.29** X-220. Carton of 3 asst.

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Universal high output crystal for public address, home recording and communications. Equipped with cradle and desk base and 6' shielded cable. A beauty, too, for the price! Size 3½" high, 2" dia. Shpg. wt. 1 lb.

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Westinghouse, G.E. and Tung-sol panel lamps. Just what you need to replace the lens.

Stock No.	Type No.	Price
X-161	41	
X-174	44	**$5.19**

OLSON KNOB KIT with Steel Cabinet

A drawer with 12 compartments to store all your knobs. Kit contains 6 each of 1" and 1½" knobs, 12 each of 1¼" knobs, 6 each of 1¾" knobs, assorted of 50 set screws and nuts, 2 pointer knobs, 1 pair of pliers, 1 screwdriver for setting them at such a position that they look just right. Shpg. wt. 4 lbs.

X-150. Special each **$11.95**

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Strips off insulation clean and fast. Adjusts for wire sizes 10 to 14 and has 4 hole cutting assembly for tough jobs. Automatic grip releases when wire is stripped. Has complete without this handy tool.

TL-1 ..... **$2.95**

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Every service shop needs one of these handy tools made by Fairchild. Famous manufacturer of precision electric grinders. Regular nationally advertised price is $19.75.

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If you have any good, clean surplus radio material which you wish to dispose of, contact Olson at once. We can use: radios, amplifiers condensers, chassis, phono motors, pickup arms, volume controls, test equipment, speakers, in fact any radio or electronic part or piece of equipment.

Here is your opportunity to turn idle inventory into cash. Write, wire or call Olson, the popular name in radio.

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Completely all weather. Made by Famous Manufacturer. 10 Watt Paging Speaker. An outdoor or indoor all weather paging speaker. Capable of continuous 10 watt operation. You get the complete unit consisting of an Alnico 5 driver unit, a 12" cone and a matching exponential horn with swivel bracket. Bell diameter is 7". Regular list price $40.00. Ideal for paging. Factory sealed cartons. Shpg. wt. 4 lbs.

S-150. Special each **$11.95**

Trumpet and 25 Watt Driver Unit

All Weather Trumpet: 19" diameter bell, equivalent to a 24" exponential trumpet. Made of aluminum castings and spinnings. Can be used with driver listed here or any other standard driver. Factory sealed cartons. Shpg. wt. 12 lbs. Regular list price $30.00.

S-152, special each **$13.50**

The most popular combination on the market. This driver and trumpet is perfect for indoor or outdoor use in sound trucks, churches, parks, etc. Fully guaranteed by well known famous manufacturer. **Driver Unit:** 25 watts. 15 ohms. For use with trumpet offered here or will fit any standard trumpet. Order trumpet and driver as a unit or each sealed carton. Shpg. wt. 9 lbs. Regular list price $25.00.

Stock No. S-151, special, each **$12.50**

SPECIAL COMBINATION OFFER

Olson will supply you with a 25 watt Driver Unit S-151 and an all weather trumpet S-152 at the special price of both for **$23.95**

OLSON'S GIGANTIC NEW AKRAD KIT—WITH 4-DRAWER STEEL CABINET FREE

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We have a limited quantity of Olson Akrad "Super Sealed" capacitor kits remaining in our warehouse. Each cabinet, size 9½x8½x4¾, drawers have compartments. Condensers are designed to give long dependable service in home use.

Kit Contains 42 Condensers

You get the 4 drawer steel cabinet and the following 42 Olson Akrad "super sealed" By-pass condensers.

Qty.	Cap.	Volts	Qty.	Cap.	Volts
2	.001	600	2	.02	600
2	.002	600	10	.1	600
2	.005	600	5	.005	1600
2	.01	600	5	.008	1600
5	.02	600	5	.01	1600

GE RECORDER AND PLAYBACK

Stock No. RA-53, complete w/ 1 tube and 2 discs **$17.95**

A real recorder for children. Discs can be erased and used over. Made by GE and known as Dictaphone. Recording plays back instantaneously. Each disc plays 2 minutes. Equipped with magnetic dictating and playback head, 3 speed (78-45-33⅓) motor, combination microphone and speaker, and timing knob. Complete with 2 discs and 1 tube. Factory approved. Shpg. wt. 15 lbs. Regular Price $30.00.

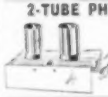
This is a fine item for children and will satisfy them. It is not a high-fidelity recorder intended for commercial use.

JENSEN PM SPEAKERS
Olson's Big Bargain Value

Genuine Jensen PM speakers for PA or radio use. Cone and coil assembly ready to assemble. Heavy Alnico V magnets. Order large.

Stock No. S-12. 12 Watts. 12" Dia. Shpg. Wt. 7 lbs. Net **$7.95**

2-TUBE PHONO OSCILLATOR KIT



Connect to any phonograph and it will transmit to any radio in the house without wires. Full instructions, all parts and tubes included. Ship. wt. 3 lbs.

RA-46 Oscillator Kit. **$3.29**

RA-47. Assembled **$4.29**

TV BOOSTER KIT R-A-26 **$9.95** Complete

Build your own TV-FM booster. Improves reception in fringe areas. Has 5 db gain in signal to noise ratio. All channel tuning. Complete with RMA tube, pre-aligned coils, etc. Shpg. wt. 5 lbs.

IT'S DIFFERENT—IT'S AMAZING—IT'S GREAT

IT'S NEW!

The OLSON LOUDMOUTH

ONLY AT OLSON'S

RA-43 Complete with tubes and Electro-Voice Microphone. OLSON'S Special Price, only .....

$34.99

EACH

A complete sound system • Inputs for both microphone and phonograph • Electro-Voice Microphone included • Underwriters Laboratories approved components

An entire sound system capable of delivering 6 watts of watts peak at less than 5% harmonic distortion. Has input jacks for microphone and phono, two controls, one for volume and one for tone. 8" heavy duty built in PM speaker, safety fused circuit. Hum free operation. Indicating pilot light. Suitable for use by musicians, singers, lecturers, bands, clubs and any other entertainment application. The dual-channel input permits mixing of singing with the playing of phonograph. Frequency response, ± 2DB 100 to 8,000 cps. Power gain 105DB. Tubes 6SL7GT, 6V6GT and 6X5GT. Hum level 60DB below output level of 6 watts. Power consumption 30 watts at 117 volts, 60 cycles. Dimensions, 11¾x8¾x13" high. Genuine leather carrying handle, beautiful two tone grey and blue carrying case with sloping control panel. Completely assembled ready to operate. Shpg. wt. 15 lbs.

OLSON AKRAD

THE HOUSE OF RADIO AND TELEVISION BARGAINS

PRICE SLASH ON GENUINE MAGNAVOX (The Oldest Name in Radio) PM SPEAKERS.

Latest designs to come from the Magnavox laboratory. Super Alnico 5 magnets employed. Voice coils built to utilize every bit of input power and to deliver volume and fidelity you never dreamed possible. Each speaker individually packed in an attractive carton. The name Magnavox on each speaker is your guarantee of the best. Voice coil impedance 3.2 ohms on all speakers except 12" which is 8 ohms.

S-142

S-143

S-141

S-140

Stock No.	Size	Watts	Olson's Price
S-142	4"	3	$1.39
S-143	5"	4	1.49
S-141	6x9"	6	2.99
S-140	12"	9	4.95

WESTERN ELECTRIC 30 WATT SPEAKER

728-B Speaker, Special

$31.20

The famous Model 728B Western Electric Speaker made to sell for more than $100.00 now yours at this terrific reduction. Developed by Bell Telephone Laboratories. Handles 20 watts continuously. Diameter 12", Voice coil 4 ohms.

RCA 8" PM SPEAKER

$3.49

S-123

Known as the RCA "Mighty 8." Delivers tremendous volume because of advanced engineering and super-size Alnico 5 magnet. For radio and PA use. Voice coil 3.2 ohms. Shpg. wt. 6 lbs.

NEW INTERCOM

OLSON'S SPECIAL PRICE

MASTER STATION

$10.99

RA-40

RA-41 Substations, Each

$4.49

A real high quality Intercom ideal for home, office, nursery or sickroom. Quickly installed without tools. Remote stations may be placed as far away as 2,500 feet. Beautifully designed plastic cabinets with sloping front. Amico 5 PM speakers deliver ample volume. Has on-off switch, push-to-talk switch and volume control. Master station uses 12SJ7, 50L6 and 35Z5 tubes. Size of cabinets 5½"x8½"x4½". One or more substations may be used with the master station. Master station with tubes and 50 ft. of 2 conductor cable.

LATEST MODEL CO-AXIAL SPEAKER

12"

Single, each

$12.95

S-122

$12.50

Lots of 2 Each

Woofer-Tweeter design. Response 40 to 17,500 cps. Months of research went into the design of these high efficiency speakers. Discard your old speaker and order one of these hi-fi jobs. Only 2 wires to connect. The 12" section is driven by a super heavy duty 22-oz. magnet which reproduces the low or bass notes. The 4" section is especially designed to reproduce the high notes. Together they give you true and beautiful reproduction covering 40 to 17,500 cycles. Comes complete with the high pass filter built-in. Order your Co-axial speakers from Olson, the speaker specialist.

4-Drawer All-Steel Chest

For small parts, etc. knob on each drawer. 9 various size compartments. Each drawer 1¾" deep. Size: 6¾", H. 5¾" W. 8⅝" D. Shpg. Wt. 5 lbs.

X-199—Each .....

$2.19

WELLER SOLDER GUNS

Built-in spotlight. Heats in 5 seconds. Heat goes off when trigger is released. Streamlined design. Available in four models, operates on 115 V. AC. Shpg. wt. 4 lbs.

Model	Watts	Olson's Price
WS-100 Single Heat	100	$11.75
WS-200 Single Heat	200	12.69
WS-135 Dual Heat	100/135	13.67
WD-250 Dual Heat	200/250	14.65

HOW TO ORDER

How to order: Order directly from this ad. For convenience use this order blank. Fill in columns below with quantity desired, stock number, description and price. You may send remittance with order (include enough for postage or parcel post shipment), or if you prefer SEND NO MONEY. Olson will ship C.O.D. and you may pay mail or expressman for merchandise and postage.

MONEY BACK GUARANTEE: *Everything you order from Olson is guaranteed as advertised. If you are not more than satisfied, you may return merchandise for cash refund.*

Please Minimum Order $3.00

RADIO CHASSIS

79¢ each

X-228

Real value for the experimenter. Each chassis contains 4 sockets, and one output transformer to match single tube to 2.5 ohm voice coil. Approximate dimensions 4x10x11". Transformer alone is worth 79c, but Olson's price is 79c for everything.

RADIO CHASSIS

2-Band chassis partially assembled. 6 tube set but only 4 tubes are included (1—6SQ7, 1—6SJ7, 2—12SK7). 1—140 ohm output and rectifier tubes are not included. Includes a 3-amp condenser, 3-section filter condenser, 6 sockets, 4 tubes, set of shielded RF, Antenna, Oscillator and 2 IF transformers, band switch, volume control, tone miles condensers, resistors and trimmer. Circuit diagrams are not available. Shpg. wt. 10 lbs.

$6.95

RA-49

HOOK-UP WIRE KIT

How can we give you so much high grade wire for so little? Olson bought all the surplus wire in a huge factory, the biggest bargain in it was 500 ft. of wire, total 5000 ft. Various colors, push back, plastic and rubber insulation and stranded copper. Shpg. wt. 5 lbs.

AS19, 500 feet.....

$3.95

PHONO AMPLIFIER

Connect to phono or speaker to get the thing you've certainly. Uses 1T9GT, 50L6, 35Z5 tubes, 3 controls on off tone and tone. 7½x9¼x5". Shpg. wt. 2 lbs.

AS-22 **$2.64**

RA-19 **$3.98**

GE RECORD PLAYER

Only

$8.95

Model 19

Attractive compact modern quiet 331/3 RPM motor, on-off switch and hardy-one pick-up with genuine GE sapphire reluctance phono cartridge and permanent needle. Brand new factory sealed cartons. Can be used on any set with pre-amp. Operates on 115 volts AC. Regular price $19.95. Shpg. wt. 5 lbs.

RIM DRIVE PHONO MOTORS

Famous Makes! Real bargains at these low prices. Self-starting, complete with turntable, mounting bracket. Shpg. wt. 4 lbs.

M-52, 78 rpm for 115 volts AC.....

$3.29

M-63, 3-speed, 33⅓, 45 and 78 rpm.....

5.49

ASTATIC "TURNOVER" PICK-UP ARM

Cartridge turns by means of knob on front. One side plays 33⅓ and 45 RPM records and other side plays 78 RPM, only 8 grams needle pressure. Includes the famous ASTATIC 1GD-1 Double-needle cartridge. Die cast curved arm. Equipped with 2 long life needles. Frequency response 50-5000 cps output 1.2 volts. Shpg. wt. 2 lbs. Reg. list price $15.00.

M-64 OLSON'S SPECIAL PRICE, each.....

$4.95

GENUINE ASTATIC PICKUP ARM

With crystal cartridge ..... at less than you'd normally pay for the cartridge alone.

M-58

OLSON'S Special Price, each.....

$2.99

QUANTITY	STOCK NUMBER	DESCRIPTION	PRICE EACH	TOTAL

NAME _____ TOTAL

ADDRESS _____ ADD: POSTAGE

CITY _____ ZONE ____ STATE ____ TOTAL AMOUNT

BN-1150

Cut Out and Mail to: **OLSON RADIO WAREHOUSE, INC.** 73 E. MILL ST. • AKRON 8, OHIO

Electronic Compressor

(*Continued from page 64*)

sion at all frequencies from 200 to 10,000 cycles.

Only one adjustment is necessary after the construction is completed, that of R_9. With a v.t.v.m. or oscilloscope connected at some point in the circuit beyond the limiter, apply an audio signal of about 1500 cycles to the input, and adjust its level to 3 volts at the grid of V_1. Set R_9 to maximum resistance and observe the amplitude of the output. Now increase the input

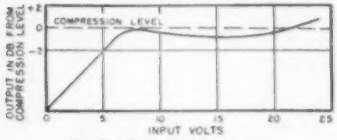
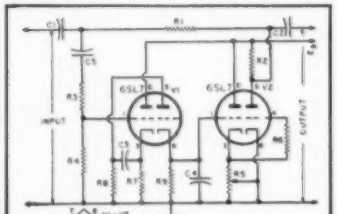


Fig 3. Compression curve.

to about 15 volts to the grid of V_1, and adjust R_9 to give the same output amplitude as was noted with the input of 3 volts. Repeat this procedure, leaving R_9 untouched at the low input. The unit is now adjusted and should show a compression curve very similar to that given in Fig. 3.

The practical applications of this limiter are wide and varied. This unit has been used commercially in many phases of broadcast work at radio station KAVR. Illustrating its flexibility: The limiter has been used for approximately 6 months in place of the standard commercial limiting amplifier and has been found to be more effective, because of its instant compression. These units have been placed in remote lines and in the network line to assure constant program level to the control board, allowing the control board engineer freedom from "gain riding" on incoming programs. It has also proved itself in recording applications.

Fig. 4. Circuit diagram of deluxe version. Values shown are for a limited range of audio frequencies and for a relatively fast compression, slow expansion time.



R_1, R_2, R_3, R_4—470,000 ohm, ½ w. res.
R_5—25,000 ohm (max.) pot.
R_6—15,000 ohm, ½ w. res.
R_7, R_8—10,000 ohm, ½ w. res.
R_9—1 megohm, ½ w. res.
C_1, C_2, C_4, C_5—.01 μfd., 400 v. cond.
C_3—10 μfd., 25 v. elec. cond.
V_1, V_2—6SL7 tube
Note: Values of R_7 and C_4 can be changed to alter speed of compression.

For ham use, its assets are readily apparent. It does away with one of the greatest bug-a-boos of the radio amateur, overmodulation, at practically no additional cost.

Circuits of this type should find wide usage where space or cost considerations have heretofore prevented the use of a compressor. Because this circuit has no amplification, it is necessary to amplify the output before incorporating it in a previously designed amplifier, but one triode stage is usually sufficient. Thus it is possible to have effective volume compression over a range of up to 20 db. change in input with only three triodes, and if a twin-triode (such as a 6SL7GT) is used, that means only two tubes. Distortion is negligible and the rate of compression is fast. If even faster compression is desired, the circuit of Fig. 4 (page 110) can be used.

With proper design almost instantaneous compression can be accomplished. Other circuit factors than those shown in Fig. 2 (page 64) affect parts values and those shown are for average use.

—30—

The "Auditioner"

(*Continued from page* 51)

ized preamplifiers, with an output connection from the preamplifier section to permit connecting to the phono input of tuners in a complete system with radio. Two rows of switches are assigned to amplifiers, one for the input of the built-in preamplifiers and speaker output, and one for the high-level input and speaker output. Each amplifier, then, has two buttons assigned to it. With buttons in the "up" position, the inputs and outputs of each of the components connected are shorted. Depressing a button opens the shorts and cuts the unit into the line. Since the photographs were taken, another row of speaker buttons has been installed to provide for switching up to 25 speakers. Also included is a speaker "T" pad for adjusting levels to speakers at the control panel. This pad is also effective for demonstrating relative speaker efficiencies.

Contacts are provided at each push-button switch position for controlling lights in the center panel. 6.3 volts a.c. is used. The console itself is of all-steel construction. It is finished over-all with *Meyercord* decal in the bleached mahogany crotch pattern, very closely simulating natural wood. It measures 58" long, 43" high, and 33" deep.

Demonstrations with the "Hi-Fi Auditioner" have been most effective. While it would take a lifetime to listen to every one of the 371,293 possible combinations, the quick selection of combinations in which any one person may be interested, has resulted in faster and better service to *Allied's* customers.

—30—

Spot Radio News

(*Continued from page* 18)

cult to construct equipment which is as precise and uniform in response as required for accurate registration. It is even more difficult to maintain the precision as time goes along, for the electrical component parts age." The *CBS* system, however, was praised for, according to the report, . . . "it is not troubled by other than minor registration problems at the camera or receiver. These minor problems arise from power supply hum, stray fields, and vibration, but they are easily cured. . . . Color breakup and color fringing were observed at the demonstrations on the disc receivers. The use of long persistence phosphors should minimize the color breakup at the receiver. Color fringing, moreover, will still occur due to the use of the color disc at the camera." *RCA* did not fare too well in its tests of registration, according to the FCC, who stated that . . . "registration, both electrical and optical, is a severe problem at the camera and receiver. At the camera this is due to the fact that three separate pickup tubes are utilized." At a demonstration of a receiver employing a single tri-color tube, FCC also noted that . . . "there was evidence of faulty registration." However the comment was modified by the statement that . . . "such registration may have been the fault of the camera rather than a receiver, since a misregistered picture results if there is misregistration in either the optical or electrical aspects of the camera or receiver. . . . *RCA* did testify that a single tri-color tube could be developed for the camera which would have correct registration built into it. No such tube was demonstrated or was there any testimony that one had been constructed." And then the government reps said quite sharply . . . "It is difficult for the Commission to see how the *RCA* system could utilize such a tube even if one were constructed. . . . The principle of mixed highs upon which *RCA* relies so heavily requires, by its very nature, a simultaneous camera pickup of three color signals."

ANALYZING COLOR FIDELITY, the report disclosed that at all of the demonstrations on record . . . "*CTI* had difficulty with color fidelity because of faulty registration." *CBS* won a point in this test, too, for according to the FCC . . . "the color fidelity of the *CBS* system, as demonstrated on the disc receiver, has been of uniformly high quality." *RCA* failed on this score, said the Commission, for at the demonstrations, they " . . . had difficulty producing a color picture with adequate color fidelity." The comment was amended, however, by a statement covering a special demonstration, during which the color fidelity of *RCA* pictures was found to be adequate.

NIAGARA!—ONE OF AMERICA'S GREAT ELECTRONICS STORES

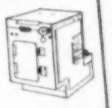
TO OUR TUBE BUYING PATRONS

Many popular receiving and T.V. tube types have become extremely difficult to obtain. As some numbers reappear, others become scarce. Daily price fluctuations prevent us from preparing our usual monthly tube listing (submitted to RADIO NEWS two months before you see it) with any degree of accuracy.

We still claim to have one of the largest stocks of tubes in the country and probably can supply most if not all of our customers, however, all tube orders will be accepted "first come first served" and dependent upon current prices and availability.

Quotations will remain valid for no more than 48 hours (two days) and are subject to change thereafter. Don't waste time—it can mean money! Write, phone or wire your tube order today!

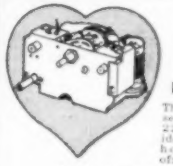
SPECIAL SCOOP ARC 5/R—28 2 METER RECEIVER



HOTTEST 2 METER RECEIVER available today. 4 channel XTAL controlled with relays, easily converted. Covers 100—156 MCS. Supplied with all tubes, 4—717A, 1—12A6, 3—12SH7, and 2—12SL7 gt. Originally $65.00. Brand new—original cartons.....

$19.95

WOW!



HEART OF THE BC-221 FREQ. METER

This VFO Sub-Assembly, used in BC-221 Freq. Meter, is ideally suited for home construction of:

1—Amateur V.F.O.
2—Freq. Mtr. Foundation
3—Portable Transmitter
4—Replacement for BC-221

Unit contains two temperature and moisture compensating coils, wafer switch, 3 variable condensers, carbon resistors, and silver mica condensers. FULLY WIRED and mounted on sturdy aluminum sub-chassis, ready for installation. Brand new—in original packing.

New Low Price..... **$4.95**

BIGGER BARGAINS!

T-17 MIKE

Lowest Price Ever! Slightly used, guaranteed perfect and clean. Single button carbon handmike. Light, efficient, 200 ohms. Press-to-talk switch. 5-ft. rubber cord with PL 68 plug attached.

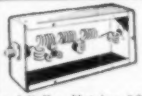
Used 2 for $1.00. New $2.50 each

New Low Price Niagara Famous High Pass Filter

Banish interference with Niagara's Hi-pass filter! Positive protection against interference from amateur transmitters, shortwave, and all other devices generating radio frequency interference below 40 MCS. Designed for 300 ohm leadin. No loss in brightness or clarity. Wired and tested.....

$2.50

Postpaid if entire amount is included with order.



LOW PASS FILTER

Don't be blamed for TVI! Tests have proven that Niagara's low pass filter attenuates all frequencies above 40 MC. May be used on all bands from 10 to 160 meters. Will easily handle a full Kw. Matches 52-72 ohm line. Plus 25c shipping charges in U. S. A.

$4.99

TRANSFORMER BARGAINS!

Plate

750-0-750—300 MA.	$ 7.50
1025-0-1025—500 MA.	17.95
2500 V.—4 MA.	3.95

Filament

2.5V-5A, 7.5V-4A	$2.60
2.5V.-10A cased	4.95
5 V.C.T.-3A	1.35
5V-10A	1.85
5 V.C.T.-10.5A	2.15
5 V.C.T.-15A	5.95
6.3V-3A	1.29
6.3 V.C.T.-3.5A	1.49
Three 6.3 V.C.T.-4A each	1.80
6.3 V.C.T.-6A	1.85
6.4V-8A	2.05
7.5V-5A	2.49

Power

40-0-40—250 MA.—5V-3A	$1.25
55-0-55—250 MA.—5 V.C.T.-3A, 5 V.C.T.-3A	1.35
175-0-175—150 MA.—6.3V-6A	2.15
275-0-275—70 MA.—5V-5A, 2.5V-10.5A	3.00
325-0-325—40 MA.—5 V.C.T.-2A,2.5 V.C.T.-4A	2.25
325-0-325—70 MA.—6.3V-1.2A, 5V-3A	2.95
350-0-350—70 MA.—5V-3A, 6.3V-3A	3.05
350-0-350—100 MA.—6.3V-6A, 6.3V-2A	3.25

Modulation

807 to P.P. 6L6	$2.49
P.P. 807 to single 6L6, 4D32 12400 ohms	3.49
From 200,500 ohms to 5, 6, 7, 8, 9, 10K ohms at 150 MA.	4.49

Driver Xfmrs.

200, 10,000 ohm P. to single G.	$ .79
10,000 ohm P. to single G.	.89
P.P. 45, 2A3, etc. to P.P. 210, 801, etc.	1.95
P.P. 6L6, 2A3, etc. to P.P. grids	1.65

Output

P.P. par. 2A3, 45, etc. "All" to 4, 8, 15, 500 ohms	$1.89
6V6 to 2, 4, 8 ohms	.69
P.P. par 6N7 Class "B" to 8000 ohms	1.49

Input

600 ohm C.T. to 300 ohm mike	$1.49

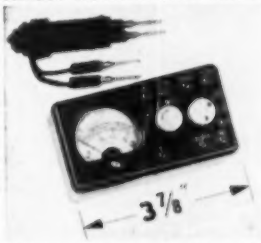
Mike to Line

From and to 50, 125, 200, 330, 500 Ohms	$2.49
30 ohm mike to 600 ohm C.T. Bal. line	1.65

Chokes

.875	HY.	2.5 Amps	$8.95
2.5	HY.	4 Amps.	8.95
2.5	HY.	130 MA.	1.10
4	HY.	40 MA.	.25
8	HY.	200 MA.	2.35
10	HY.	180 MA.	3.49
40	HY.	90 MA.	
10	HY.	200 MA.	2.49
10	HY.	150 MA.	1.75
12	HY.	125 MA.	1.60
15	HY.	200 MA.	2.65
20	HY.	125 MA.	1.75

TINIEST V.O.M. IN THE WORLD



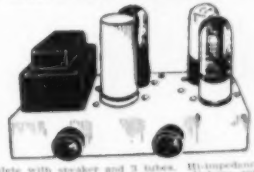
NIAGARA exclusively presents the "Universal Baby Tester" measuring 3⅛"x2¼"x1-5/16" D. Contains a sensitive 0-250 microammeter with the following ranges:

- 0-7.5V AC or DC
- 0-150V AC or DC
- 0-750V AC or DC
- 0-150 DC MA.
- 0-100,000 ohms

Ohms adjust and DC-AC-OHMS switch. Includes 1 pair test leads. Will fit into your watch pocket. Fully guaranteed. Special

$8.95

5 WATT AUDIO AMPLIFIER



Complete with speaker and 3 tubes. Hi-impedance output for XTAL mike or Phono-Pickup. Volume and tone controls. 5 W. amplif. with 5" speaker.....

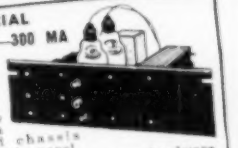
$8.95

Same as above with 8" speaker

9.95

MORE LINES!

SPECIAL 1500 Volt—300 MA Power Supply Kit



Complete with punched chassis, 19½" rack panel, tubes, choke, transformers, hardware etc. WHAT A BUY!.....

$24.95

SALE!

274N and ARC-5 XMTRS and RECEIVERS

2.1-3	MC. Xmtr.	$14.95
3-4	MC. Xmtr.	19.95
4.5-5	MC. Xmtr.	12.95
5.3-7	MC. Xmtr.	12.95
7-9.1	MC. Xmtr.	24.95
190-550	MC. Rcvr.	14.95
550-2000	MC. Rcvr.	24.95
3-6	MC. Rcvr.	7.95
6-9.1	MC. Rcvr.	7.95
190-156	MC. Rcvr.	19.95

SPECIAL NOTICE: Minimum Order $5.00. Quantity Prices on Request. All items in stock now—subject to prior sale—prices subject to change without notice. 20% Deposit with orders unless rated. All prices F.O.B. our N. Y. Warehouse.

Niagara Radio Supply Corp.

Phone Digby 9-1132-3-4

Dept. N-110 — 160 Greenwich Street, New York 6, N. Y.

Resolution received an extremely comprehensive study in the report. Reviewing the method used by *CTI*, the government experts declared that . . . "In theory the resolution of the *CTI* system should approach that of the present system. This has not been the case, for at none of the demonstrations did *CTI* produce a picture which could compare in resolution with black and white television. The reason for this lies in the faulty registration . . . and in the line crawl which is present in the system." Detailing the approach used by *CBS*, the report stated that since this system produces 405 lines as compared with the standard 525, the vertical resolution is below that of the present system. In addition, the use of 144 fields per second, with a resulting line scanning rate of 29,160 per second results in a loss of horizontal resolution, too. A reduction in vertical resolution by 23% and horizontal resolution by 46%, as compared with the current standards, was cited by FCC. The *RCA* system, which produces lines at the same rate as the black and white system, seemed to suffer in the practical demonstrations, the FCC noted. They felt that this was due to cross-talk and the use of mixed highs, plus misregistration.

The vote on the plan to adopt the so-called *bracket* standards, for 405 and 525 pickup, a 4-2-1 affair, disclosed just how the Commissioners felt about the whole problem. On the majority side of four, asking for the interim standing, were the FCC Chairman, Wayne Coy, and Commissioners Walker, Sterling, and Webster. Favoring immediate adoption of the *CBS* standards were Commissioners Hyde and Jones. And Madame Commissioner Frieda Hennock asked for a deferrment of final judgment until next June.

Citing her views on the problem, Madame Commissioner Hennock said that she could not agree with the premise . . . "that in the event bracket standards are adopted a tentative determination to adopt an incompatible system should be made." In her opinion, such a decision would . . . "be premature." She felt that . . . "there are many indications that intense effort is being exerted to overcome the difficulties inherent in compatible color systems. Off-the-record developments by *Hazeltine*, *G-E*, *CTI*, and *RCA* may be bringing us a little closer, if not near, to the realization of a practical compatible system. In any event we should work toward that end with all our energy until the last possible moment, and not foreclose the possibility of its achievement until convinced that it is a practical impossibility."

A STRONG DISSENTING OPINION on the compatibility phase of the bracket plan was also included by Madame Commissioner, who declared that . . . "Incompatibility will . . . pose a serious problem for the broadcaster, and its effects will very likely be felt by all television viewers. To the extent that there are receivers in the hands of the public which are unable to receive field-sequential color broadcasts, every program broadcast under those standards entails a loss of audience for the broadcaster. Our broadcasting system is dependent for its economic existence upon advertising revenue, and the advertising value of a broadcast varies directly with the number of people which it can reach. The decision to produce a program in color will be a difficult one for the broadcaster to make if it means that the program will thereby become less salable. The transition to color, must, when viewed in this light, be long and difficult. With compatibility, any program could be produced in color, without loss of audience, and a great impetus would be provided for the purchase of new color receivers."

Praising the possibilities of the new art, Miss Hennock said: "Color television, I feel, is a great forward step, with untold potentialities for the improvement of television for education and industry, as well as entertainment. But it has been decided by this Commission that the most desirable course to follow would be to allow more time for the development of all color systems, including the *CBS* field-sequential system. In view of this fact, and the fact that the problems posed by incompatibility will be frozen at their present level, I feel that every encouragement should be given the development of a compatible color system. It would be improvident, in my view, to allow only as little as three months for such a significant and difficult development to take place. I therefore feel that the date of final decision in this matter should be postponed until June 30, 1951."

IN A CONTRARY VIEW, Commissioner Rosel Hyde declared that he was of the . . . "opinion that such dislocation and inconvenience as will necessarily be caused by the introduction of a color system, would be minimized by definitive action now. Such dislocation and inconvenience would be magnified by the absence of final action during the period of indecision, the length of which cannot be precisely determined at this time. Purchasers of new sets, who would have had the option of obtaining color sets immediately, if they so desired, will now be forced to elect either to purchase a set which will require conversion to color or to await final action at some future undeterminable date. Manufacturers would have been able to devote their full television research facilities and energies towards the further improvement of one proven and accepted system . . . instead of dissipating them in further attempts to surmount difficulties which may be inherent in non-field sequential systems. . . . Broadcasters would have been able to begin immediate experimentation with color programming

TAPE RECORDER NEWS

from **THE BRUSH DEVELOPMENT COMPANY, Cleveland 14, Ohio**

NEW SOUNDMIRROR® ARRIVES!

New Design– Silent Control– More Power– Are Features

It looks like a fine piece of luggage. It has the quiet operation of a high-priced phonograph. It possesses great power output, self-contained speaker . . . superb playback quality. These are the high lights of the new Soundmirror by Brush.

Long famous for its precision characteristics, the new model is a *third smaller* than any traveling tape recorder previously made by Brush. Further refinements . . . microphone storage compartment; a readily-accessible telephone jack for input hookup from radio, phonograph or other source, and output for playback through any speaker; . removable cover with lock-type hinge.

NEWEST AND FINEST of magnetic tape recorders is this new Soundmirror by Brush. The case in beautiful two-tone tan looks like fine luggage and is perfectly balanced for easy carrying. A reel of "Magic Ribbon" plastic tape (30 or 60 minutes) is supplied without additional charge with each new machine. BK-443-P will record for 30 minutes. BK-443-PS, similar to it in every other way, takes recordings up to an hour. Priced at $279.50 (30 minutes), $289.50 (60 minutes), complete.

Leaders in Tape Recording Bring New Standards to Amateur Field

The trade will call the new portable Soundmirror the most useful magnetic recorder ever to be introduced. It is not "technical" electrical equipment, like recorders in the $500 to $1,500 class, nor a "toy"; it combines popular price, high flexibility of use and faithful recording in a mechanism any amateur can learn to operate in five minutes.

Yet all through, to the very tape itself (on a rigid metal reel), to its RCA high quality accordion cone speaker and the Soundmirror's high output, it is built to the finest precision standards.

Five new Brush models, including the Educational Soundmirror, include the same advanced features at practical prices ranging from $199.50 to $289.50.

NEW "Magic Ribbon"* for All Recorders

The new "Magic Ribbon", magnetic recording tape (plastic or paper base) by The Brush Development Company, wound on a rigid metal reel to assure professional standards, can be used with all makes of tape recorders employing quarter-inch tape.

Brush tape is packaged in the library album hinged box which makes indexing and storing as easy as putting a book on a shelf.

*Trade-Mark

Latest Brush Achievement Praised by Many Experts

Brush has always made magnetic recorders to professional standards, no matter how popularly priced an individual model might be. The new models just announced are no exception. "Previewed" and "preheard" by such professionals as radio people, musicians and engineers, the new recorder was highly praised.

Many professional people use the portable Soundmirror for street interviews, local recording and other purposes.

The Soundmirror produces such high fidelity and successful results because of such professional features as the eye record volume indicator, the provision for setting volume record level in advance of recording, full precaution against unwanted erasure, and the automatic silent brake stop switch at the end of playback or record.

This is why the Soundmirror is known as "the professional tape recorder amateurs find easy to use".

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FOR MORE THAN 10 YEARS LEADERS IN MAGNETIC RECORDING

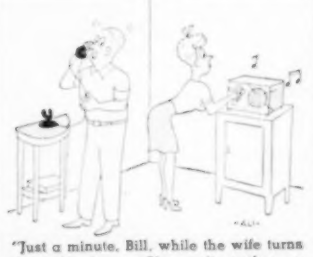
techniques, assured of a progressively growing audience during the period of transition. . . . I hope that the fears expressed by the majority and me will not be realized, and that industry will cooperate with the Commission in reaching the goal by not requesting unnecessary or unwarranted delays."

In the third separate opinion, bitterly dissenting with the majority's action in leaving the door open for future discussion of other possible systems, Commissioner Jones declared that the fundamental disagreement between the other Commissioners and himself was that he was for color now. Elaborating on this point acidly, he said: "Whatever the protestations or words of the majority, their action on this day is most certainly *against* color now." Continuing his criticism of the other Commissioners' decision, Jones said: "Two systems, *RCA*'s and *CTI*'s, claimed at the beginning of the hearing to be fully compatible and to render a high standard of performance. They failed on both counts throughout 9700 pages of record and in the individual and comparative demonstrations held over an eleven-month period . . . The third system, *CBS*'s, fully complied with the Commission's public notice of May, 1949. . . . *CBS* successfully demonstrated on the same record and in the individual and comparative demonstrations during the same period that it was adaptable, and that satisfactory black and white pictures could be received from *CBS* color signals with minor modifications on existing sets at relatively minor costs. . . . In view of the consistent record of the industry thwarting color for ten years, the Commission gambles with the only proponent who has advanced a successful system of color television these ten long years. Although the majority claims that the *status quo* will be maintained by a promise of the industry to build bracket standards into a substantial number of new black and white receivers, color still is not being fostered commercially and only black and white is being fostered. The majority says . . . 'one of the easiest methods of defeating an incompatible system is to keep on devising new compatible systems in the hope that each new one will mean a lengthy hearing so that eventually the mere passage of time overpowers the incompatible systems.' In its attempt to relieve the compatibility problem, during the period of more delay, the majority overlooks the fact that because the percentage of sets capable of receiving *CBS* color signals in black and white goes up, color is not promoted one iota. . . . We either need more information concerning direct-view triphosphor color tubes, long persistence phosphors, and horizontal interlace, or we do not, irrespective of what the industry position is. But the Commission *will* finalize *CBS* color if the majority of the manufacturers refuse to build bracket standards in black and white sets."

As this column goes to press, reports direct from Washington indicate that many of the leading set manufacturers have rejected the FCC's proposal to adopt bracket standards. While they have indicated their willingness to comply with the proposal they point out that it is impossible to meet the 30 day deadline. They claim that it will be impossible to adopt the bracket standards within the next six months.

In view of this, should the FCC stick to its guns it may approve the *CBS* color system outright. It is not improbable that the FCC may extend the time limit for manufacturers to incorporate the bracket standards. If this is done, the color tussle may enter a new tense phase of demonstrations, explanations, and sharp debates . . .

L.W.



"Just a minute, Bill, while the wife turns the radio down. She can't overhear a word you're saying!"

Within the Industry

(*Continued from page 26*)

retired from the company on the thirtieth anniversary of his employment.

He joined the Rochester firm in 1920 as head of the company's electrical laboratory. With the advent of radio broadcasting he was appointed engineer-in-charge of the company's acoustical laboratory in 1926. In the expansion of the company's activities, Mr. Olney became director of research in 1937. He is a fellow and charter member of the Acoustical Society of America and served as vice-president of the society in 1948-49.

Mr. Olney expects to continue his professional interests as a consulting acoustical engineer specializing in noise reduction and the acoustical design of buildings.

* * *

ROY M. W. GRAHAM, a rear admiral in the USN (Ret.), has been named special assistant to the manager of the equipment sales division of *Raytheon Manufacturing Company*. He will have offices at 50 Broadway, New York 4, N. Y.

Mr. Graham's duties will be in connection with harbor radar systems to facilitate the movement of ships within and in and out of ports during periods of low visibility.

He was graduated from the U. S. Naval Academy in 1919 and received his MS degree from the Sheffield Scientific School of Yale University in 1926. He retired after 34 years active naval service on July 1, 1950.

* * *

WESTINGHOUSE ELECTRIC CORPORATION has announced plans to build a new television plant at Metuchen, New Jersey. The new facility will allow the company to nearly triple its TV production . . . **W. BERT KNIGHT CO.**, technical service representative in Los Angeles, has moved to 10373 West Pico Boulevard in that city . . . **ACME ELECTRIC CORPORATION** has begun construction on a new 25,000 square foot building in Allegany, N. Y. The building will be used for the manufacture and assembly of transformer components . . . **FEDERATED PURCHASER, INCORPORATED** has opened a new store in Easton, Pa. at 701 Northampton St. . . . **SIGHTMASTER CORP.** has moved its New York office and showrooms to its new plant at 111 Cedar Street, New Rochelle, New York. . . . **THE SUPERIOR ELECTRIC COMPANY** of Bristol, Conn. has opened a Cleveland office to serve the Ohio and western Pennsylvania areas. The new office is located in Room 1118, Fidelity Building, 1940 East 6th Street . . . **THE PYRAMID ELECTRIC CO.** of Paterson, New Jersey has purchased the former *Solar* plant at 1445 Hudson Boulevard in North Bergen, New Jer-

sey and is currently in production at the new location . . . **HAYDU BROTHERS** of Plainfield, New Jersey has recently completed additional facilities to handle its greatly expanded production of electron guns.

* * *

ROBERT W. FELBER has been named sales service manager of *Stewart-Warner Electric*, the radio and television division of *Stewart-Warner Corporation* of Chicago.

Mr. Felber, a native of Chicago and a graduate in electrical engineering from Illinois Institute of Technology, started with *Stewart-Warner* as an engineering draftsman in 1945. He was subsequently a field engineer and assistant service manager for the company.

* * *

NEDA'S board of directors, meeting in executive session at Cleveland, named national officers for the ensuing year.

Arthur C. Stallman of Ithaca, New York was elected president of the organization while Dahl W. Mach of Scranton, Pa., was named to the post of first vice-president.

A. W. Greeson, Jr., of Greensboro, N. C., was elected second vice-president, Hoyt C. Crabtree of Dallas was named secretary, and Max I. Epstein of New York City was appointed treasurer of the trade group.

Mr. Stallman, who has been first vice-president for the past two years, succeeds Louis W. Hatry of Hartford, Conn., in the presidency.

* * *

L. E. RECORD has been named division engineer for *General Electric Company's* Cathode Radio Tube Division in Syracuse.

Mr. Record has been associated with the company since 1929 when he was assigned to the vacuum tube engineering department as a test man. In 1930 he was appointed to the engineering staff of the tube division and in 1933 was named section engineer for the cathode-ray tube section. He was appointed supervisor of the engineering development laboratory in 1943 and in 1949 became supervisor of the engineering development and testing laboratories, a position he held until his present appointment.

* * *

PHILIP BARNES has been appointed to the post of general sales manager of *Weston Electrical Instrument Corporation* of Newark, N. J., while **CHARLES B. DENTON** has been named advertising manager of the same firm . . . **CHARLES BEAUMONT** is the new district sales manager for *Scott Radio Laboratories* in the Washington, D. C., area . . . *Cannon Electric Development Company* of Los Angeles has named **RAY O. HILL** as controller and **JOHN K. TROTTER** as the new production manager . . . **SIDNEY S. MINAULT** is the new production manager of *Tracerlab, Inc.* . . . *The Muter Company* of Chicago has appointed **ROY W. AUGUSTINE** to its engineering staff . . . **CHARLES SCHRADER** is the director of purchases for *Potter & Brumfield* of Princeton, Indiana . . . **JOHN M. MILLER, JR.** has become the chief engineer of the television and radio research and engineering department of the *Bendix Television and Broadcast Receiver Division* . . . **GEORGE E. HALLETT**, controller of the *Tung-Sol Lamp Works, Inc.*, of Newark, N. J., has been elected president of the Newark Control of the Controllers Institute . . . **WILLIAM THIBADEAU** is the new regional sales manager for *Starrett Television Corp.* in the upper New York state, western Pennsylvania, and New England territories . . . The appointment of **JOSEPH KATTAN** as distribution manager has been announced by *Emerson Radio & Phonograph Corporation* . . . **GEORGE M. HAKIM** has joined the *Allen B. Du Mont Laboratories, Inc.*, as assistant advertising manager in charge of cooperative advertising for the receiver sales division.

—30—

Unitary Speaker

(*Continued from page 67*)

of the moving assembly suspension.

(3). It is possible to design for the desired directional characteristics by choosing the mouth geometry and flare.

The use of the *Jensen* Hypex formula horn[1, 2] makes it possible to realize better loading near the lower cut-off frequency that can be achieved with the conventional exponential

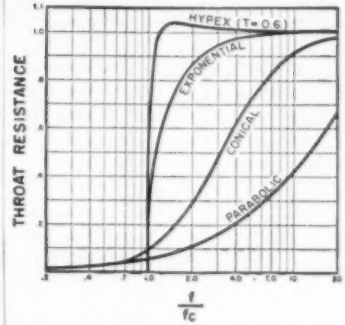


Fig. 2. The effect of throat resistance on the frequency response of various speakers.

horn. The impedance characteristic of an infinite exponential horn is that of a simple high pass constant-k filter shunted by a constant mass. The input resistance deviates from a constant value over too large a portion of the frequency region near cut-off to permit good matching. In the Hypex horns the impedance characteristics are those of m-derived high pass filters, and are analogously adjustable. As can be seen from Fig. 2, the throat resistance characteristic can be made constant to almost cut-off frequency. Therefore, the better low end performance of the Hypex horns allows use of smaller horns than if the conventional exponential formula were used. The smaller horns are correspondingly more suitable for higher frequency use, and thus a gain has been achieved at both ends.

Years of experience with all types of diaphragm material have shown that cloth based phenolic material is most suitable for compression unit driver applications. The excellent damping characteristics, plus high rigidity assure freedom from spurious vibrations and distortion which are typical of metallic diaphragms often used. The high ratio of stiffness to mass in phenolic materials makes possible superior high frequency performance at high efficiency. Whereas metallic diaphragms tend to become fatigued and embrittled after severe and prolonged flexing, phenolic diaphragms retain their desirable physical properties throughout a long service life.

The midchannel unit utilizes a rigid

[1] Electronics, July, 1941.
[2] Patent 2,338,267.

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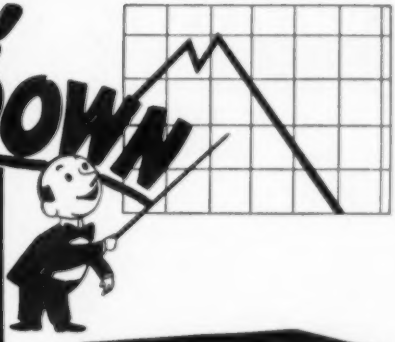

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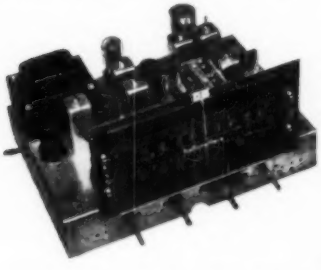

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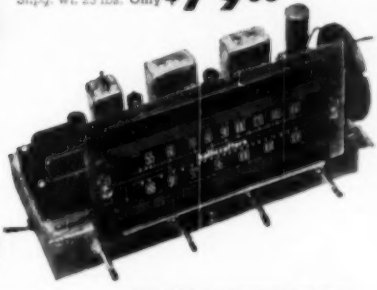

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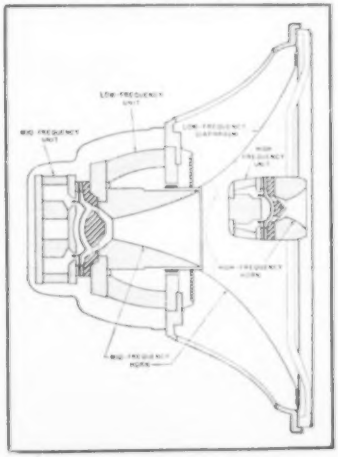
re-entrant phenolic diaphragm driven by a two inch voice coil operating in a flux density of 17,500 gauss. Operating efficiency is approximately 50 per-cent. Large clearances avoid non-linear stiffness effects which might arise due to air compression at large excursions in the sound chamber air space. The driver unit operates into a Hypex formula horn, the initial section being formed through the core of the woofer magnetic structure, and the final section being formed by the 15 inch woofer cone. Smooth performance extends down to and below the crossover frequency of 600 cycles, and up to the second crossover frequency of 4000 cycles.

The miniature compression type high frequency unit, mounted in front of the woofer cone, is small enough so that radiation from the midchannel unit is not obstructed. Streamlined surfaces and precise placement for proper phasing afford a smooth crossover transition at 4000 cycles. Its small horn achieves wide dispersion of the acoustic energy by virtue of the small mouth size and Hypex flare. While its dimensions are not sufficiently small to allow this unit to approach the spatially ideal condition of a point source of sound, a suggestion of this condition was observed when the unit was originally placed at the center of the woofer cone. High frequency energy was radiated to the sides and even to the *rear* of the tweeter unit at sufficient levels to cause reinforcement and cancellation effects due to energy reflections from the woofer cone. Optimum lateral placement of the tweeter in the woofer cone was experimentally determined as the solution to restoring the smooth response as given in free space, while retaining the good spatial distribution of this unit.

While there was no restriction on the type of network to be used for the 600 and 4000 cycle crossovers, a relatively simple 90 degree *LC* type with

Detailed view showing the arrangement of the three component speaker units.



attenuation of 6 db. per octave was chosen. Networks with greater rates of attenuation change usually bring about losses in the transmitted band with a corresponding lowering of efficiency. Use of large air core coils made it possible to attain the unusually small insertion loss of 0.3 db. The use of an air core prevents distortion characteristic of iron cores, which are subject to variation of permeability with frequency and power level.

The individual units were designed with response characteristics such that their respective contributions were small outside the crossover regions. This condition, with the network chosen, made it possible to achieve a new low in distortion over the entire audio band.

To allow compensation for sound absorption variations to be expected under different room conditions, the three-step semi-fixed "Room Brightness Control" is available. By means of this adjustment the balance between high and low frequencies may be changed to correct for different selective absorption conditions.

In cases where the frequency range of the source material or associated equipment is restricted, or where a higher-than-tolerable percentage of distortion exists, high frequency cut-off of the loudspeaker may be restricted.[1] This is provided by an adjustable four-step, low-pass filter which restricts the response in graduated steps to as low as 4000 cycles. However, a long program of listening tests has clearly shown that, even when working with the frequency range "wide open," the G-610 is tolerant of distortion in source material.

An "L" pad level control allows precise over-all volume adjustment at remote mounting positions to make the loudspeaker suitable for use in remote installations without the need for additional external controls.

The ultimate test of loudspeaker performances requires that it be listened to and the subjective effects which it produces in the listener must be evaluated by *people*. What is desired in a loudspeaker of highest quality is "*transport to the original*"—the production of the same sensations which would be experienced if the listener were actually at the original performance, and complete freedom from any and all effects which mar the illusion of reality. The extent to which this transport could be achieved was an unknown and the subjective value which listeners would place upon theoretically improved performance (in the face of existing high performance speakers) could only be speculated upon until the G-610 was completely designed.

Field experience with the Triaxial has fulfilled the expectations of its designers. —30—

OSCILLATION IN PHASE INVERTERS

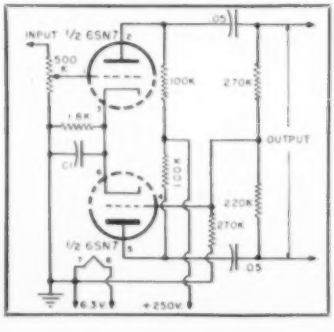
By LAWRENCE FLEMING

PHASE inverters often exhibit parasitic oscillations at frequencies around 50 kc., leading to heavy distortion and instability. The remedy is to bypass the cathode resistor of the phase inverter stage with 0.1 microfarad or more.

Parasitics at ultrasonic frequencies are quite a common cause of mushiness and low power output in audio amplifiers. Fortunately they show up at once on an oscilloscope although without a scope they are difficult to detect. If the trouble seems to depend on the gain control setting, it points strongly to parasitics.

Fig. 1 shows a conventional "floating paraphase" inverter in which the writer encountered this effect. It was found that the oscillations could be stopped by

Fig. 1. Phase inverter with cathode bypass, C_k, used to kill parasitics.



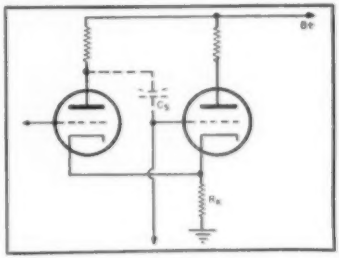


Fig. 2. Stray capacitance makes cathode-coupled multivibrator out of a standard phase inverter, creating parasitic oscillations.

a 200 micromicrofarad condenser from the top plate of the tube to ground. To avoid cutting down the high frequency response another cure was sought. A small bypass, C_k, did the trick. 0.1 microfarad was adequate, but a 25 microfarad electrolytic was put in for good measure.

It turns out that stray capacitance from the plate of one triode to the grid of the other can make this type of circuit into a cathode-coupled multivibrator, as shown in Fig. 2. Here, one triode is coupled to the other through the common cathode resistor Rk, and the return coupling for oscillation comes through the stray capacitance C_s. In all kinds of inverters, it is advisable to keep this capacitance from the plate of one triode to the grid of the other, as low as possible, by proper lead dress and layout. —30—

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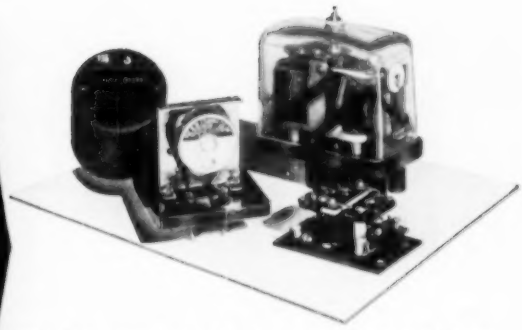

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R-804	550 VAC.	...	1B, 3B Amps.	Cutler Hammer C-261173A36 Contactor	3.50
R-250	115 VAC.	...	Adj. Cir. Breaker .04-.16A	Westinghouse MN Overload	12.95
R-579	220 VAC.	...	1B	Adlake 60 Sec. Thermo Delay	6.95
R-294	27.5 VDC.	200	1B	Edison 50 Sec. Thermo Delay	4.75
R-686	115 VAC.	...	2C	Leach 1157T-5-20 Sec. ADJ. Delay	4.95
R-246	115 VAC.	...	1B	Cramer 2 Min. Adj. Time Delay	8.95
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R-611	24 VAC.	...	1A 30 Amps.	Durakool BF-63	4.75
R-283	12 VDC.	125	AC 10 Amps.	Onan Rev. Current 3H8512 B2E	1.00
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R-262	.....	200	1C	W. U. Tel. Co. 41C Single Current	3.75
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R-660	6 VDC.	...	¼" Stroke	Cannon Plunger Relay #13672	.95
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R-295	12 VDC.	275	Armaweitar Drop	.....	2.15
R-220	5-8 VDC.	2	2A, 1C	Guardian Ratchet Relay	2.15
R-813	12 VDC.	12	Water	Ratchet Relay From Scr-522	4.75
R-275	12 VDC.	750	1A, 1B, 1C	Guardian BK-10	2.75
R-716	24 VDC.	70	2A 5 Amps.	BK-11	1.45
R-629	6-12 VDC.	35	2C, 1A	Guardian BK-16	1.85
R-629	9-14 VDC.	40	1C 10 Amps.	Guardian BK-17A	1.25
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Color Decision

(Continued from page 65)

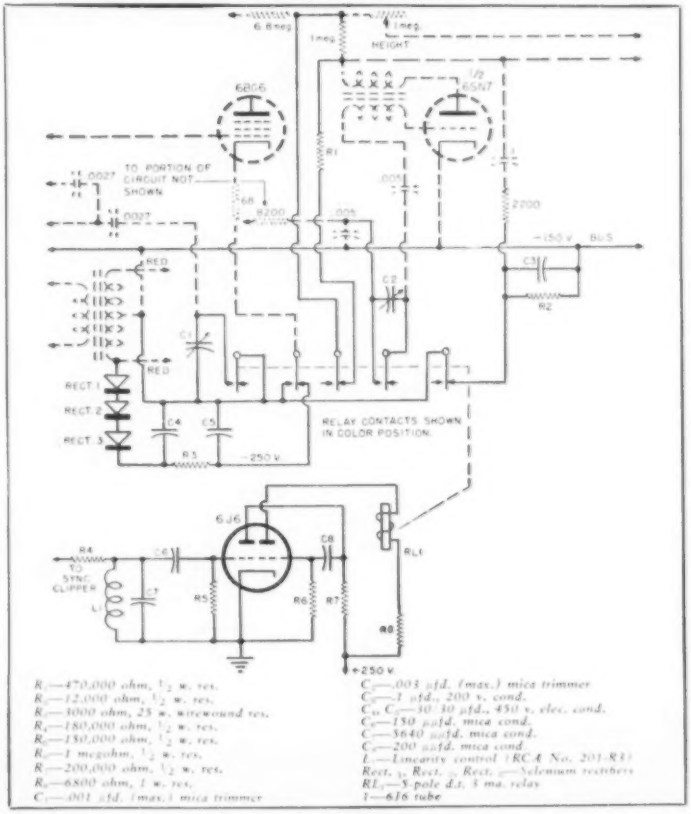
wheel. Such tubes have indeed been developed but they are still quite crude. However, there is good reason to believe that color tubes will be perfected and when this happens then it may be possible to replace your present black-and-white tube with a color tube. But this is at least 2 to 4 years off. Bear in mind that when the time does come it will not be a simple operation to convert the set. The new color tube will require quite a number of changes and additions, circuit-wise.

If the Commission's suggestions are adopted by television manufacturers, then after about November 12th of this year (unless the FCC extends this date to give manufacturers additional time), all new sets will contain switching circuits permitting them to operate on the present black-and-white standards as well as the *CBS* color standards. Note again that these sets will not be color sets but will merely permit reception of color programs in monochrome.

So much for the consumer. Now let us look to the set manufacturers. If they agree to the Commission's proposal for the adoption of the double standards, then the Commission will not make any final decision authorizing the *CBS* color system as standard. Instead, it will make further investigation into the color question to determine whether any new developments or systems have been brought to light, since the hearings closed, which will provide better results than the *CBS* system as it is now constituted. By having the manufacturers agree to the double-standards proposal, the FCC feels that compatibility then is no longer of interest and a color system can be chosen on the basis of other, more important properties.

But suppose the receiver manufacturers do not agree to make the foregoing changes? Then, says the Commission, every passing day will find the compatibility problem aggravated

Fig. 1. Schematic diagram of an automatic scanning adapter designed specifically for the Bendix Model 235M1 TV receiver. It is possible to simplify the circuit by using a manually-operated switch in place of the automatic feature. This adapter was built by E. Chapin and W. Roberts of the FCC laboratories at an approximate cost of $16.34. There are many other television receivers in the field today that cannot be as easily converted as this Bendix set. Estimated costs for converting black-and-white receivers range all the way from $25.00 to $100.00, including the cost of the labor involved.



R_1—470,000 ohm, ½ w. res.
R_2—12,000 ohm, ½ w. res.
R_3—3000 ohm, 25 w. wirewound res.
R_4—180,000 ohm, ½ w. res.
R_5—130,000 ohm, ½ w. res.
R_6—1 megohm, ½ w. res.
R_7—200,000 ohm, ½ w. res.
R_8—6800 ohm, 1 w. res.
C_1—.001 µfd. (max.) mica trimmer
C_2—.003 µfd. (max.) mica trimmer
C_3—1 µfd., 200 v. cond.
C_4, C_5—30-30 µfd., 450 v. elec. cond.
C_6—150 µµfd. mica cond.
C_7—5640 µµfd. mica cond.
C_8—200 µµfd. mica cond.
L—Linearity control (RCA No. 203-R1)
Rect.$_1$, Rect.$_2$, Rect.$_3$—Selenium rectifiers
RL_1—3-pole d.t. 3 ma. relay
1—6J6 tube

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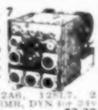

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.5	600	2TT	.25	2.40
3X.1	600	3TT	.45	4.35
3X.1	600	3ST	.45	4.35
2X.1	400	3ST	.26	2.50
2X.1	600	3ST	.28	2.65
2X.1	600	2BT	.28	2.65
2X.1	400	2TT	.26	2.50
2X.1	100	2ST	.23	2.20
2X.1	600	2BT	.26	2.50
2X.1	600	3TT	.26	2.50
.1-.1-.025	400	3ST	.28	2.65
.1	600	2BT	.22	2.10
.1	600	1ST	.22	2.10
.1	600	2TT	.22	2.10
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.0023	.75
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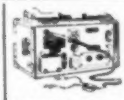

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		6.3	800	.020	
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23350	27	1.75	285	.075	APN-1
35X045B	28	1.2	250	.060	
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			440	.200	
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			150	.010	
			14.5	5	
#5053	28	1.4	250	.060	APN-1
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	26	6.3	800	.020	
			9	1.12	
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131 Liberty St., New York, N. Y. Dept. N-11 Chas. Rosen Phone: Digby 9-1124

further and the Commission will be forced to issue a final decision, immediately adopting the *CBS* color standards.

How do the manufacturers feel about this proposal? As far as could be ascertained at the time this article was written, the general consensus seems to be that even if the manufacturers did want to follow this proposal, it would be quite impossible to do so at this time. For one thing, there is an extensive shortage of parts and the proposed changes add more parts to existing sets. Secondly, there is no certainty that the change will be simple since no large scale changeover has been attempted as yet nor has there been any field testing. Finally, many manufacturers say that their top engineers are currently engaged in war work and could not be spared to do the basic developmental work. The Commission is aware of these conditions and there is reason to believe that they may be forced to give the television industry more time in which to work out the problems of adapting their present sets to the new standards.

We come finally to the television service technician, the man who will bear the brunt of the job of converting today's sets if and when *CBS* color is adopted. As noted, there have not been any attempted conversions within the industry as yet. However, FCC engineers have developed an automatic scanning adapter (as they call it) for a *Bendix* Model 235M1 television receiver. The circuit diagram is shown in Fig. 1. The dotted lines indicate the original receiver circuits of this set while the solid lines show how the additional components are connected into the circuit. The principal change in both the horizontal and vertical timing circuits is the addition of several resistors and/or condensers which are designed to change the frequency of the deflection voltages. A further addition in the horizontal output amplifier provides more voltage for this tube, enabling the circuit to produce a greater output. This increase in tube potentials is designed to raise the horizontal output voltage sufficiently to offset the decrease in efficiency of the horizontal output transformer due to the change in line frequency from 15,750 cycles to 29,160 cycles.

In Fig. 1, the circuit will switch automatically when the signal changes. This is done by means of the auxiliary circuit shown at the bottom of the diagram. The circuit connects to the plate of the sync clipper stage within the receiver and thereby receives the incoming vertical and horizontal pulses. L_1 and C_1 are made resonant to 15,750 cycles. Whenever a black-and-white signal is received, the relay in the plate circuit of the second 6J6 is actuated and the contacts adjust the circuit to operate at the monochrome line and field frequencies by bringing the proper components into the circuit. On the other hand, when a color signal is being received, the 6J6 circuits receive little or no sync voltage and the relay contacts react accordingly.

FCC engineers itemized the cost of the additional components required to build this adapter and the cost came to $16.34. Labor was not included. A reduction in cost can be achieved by eliminating the automatic feature of the adapter and making the switch-over manually controlled.

Can this adapter be made to fit all television receivers? Again a definite answer is not possible but it is believed, noting the similarity of the circuits in the majority of television receivers, that what will work in one set will work in the majority of sets. However, some manufacturers state flatly that some of their sets will require extensive alterations which will be possible only at the factory. It may very well be that some sets will not lend themselves to conversion but just which sets will be affected cannot be foretold at this time.

Of one thing the technician can be certain: His technical assistance will be essential no matter what color system is finally chosen. The wide-awake technician will keep himself fully informed of every new development reported in color television. The French call this "*savoir-faire;*" the Americans call it "know-how." In both languages it means more money in your pocket.

—30—

ORGANIZE NATIONAL FEDERATION OF TV SERVICE GROUPS

With the formation of new groups of service technicians, the need for a national organization to represent all such associations has been pointed out by Frank J. Moch, president of the Television Installation Service Association of Chicago.

Accordingly, Mr. Moch has organized a new national "association of associations." A charter has been obtained under the name of the Federated Television & Electronic Service Associations of America.

According to Mr. Moch, the new association program provides for representation in all of the industry's councils, furnishing of legal services to member groups, scheduling of technical training sessions, launching of a publicity campaign, the rendering of advice on profitable business methods, the offering of proven systems and advertising helps, representation in Washington and other political centers in all matters affecting service organizations, and the publishing of an official magazine.

Mr. Moch also advises that the association will be run on a democratic basis with representation in the form of delegates to the national association from each local association. He stresses that the national organization will not in any way usurp the prerogatives of the local groups.

Headquarters will be in Chicago with regional offices on both the east and west coasts. Those interested in additional details should contact Mr. Moch at 5908 S. Troy Street, Chicago 29, Illinois.

—30—

NEW TV PRODUCTS on the Market.....

TV BOOSTER

Approved Electronic Instrument Corporation of 142 Liberty Street, New York, New York is currently marketing the Model A-TVB television booster which has been designed for Channels 12 and 13.

The new unit, which can be used with any television receiver, is said to

provide improved reception in fringe signal areas. The booster features a bandwidth of 15 mc., input and output impedances of 300 ohms, an electrostatically shielded power transformer, a high signal-to-noise ratio, two stagger-tuned stages which are push-pull neutralized, slug-tuned coils, two 6J6 tubes and a long-life selenium rectifier.

The Model A-TVB is small enough to be installed in the television receiver cabinet and comes complete with tubes, operating instructions, circuit diagram, and guarantee. The unit measures 4" x 4¼" and weighs 3½ pounds.

TV RESISTORS

A new line of high voltage resistors for television applications has been introduced by *Resistance Products Company* of 714 Race Street, Harrisburg, Pa.

Designated Type T resistors, the new units have been specially designed to withstand the high d.c., pulse, and transient voltages encountered in TV power supplies. They may be used in voltage doubler circuits and as bleeders where ordinary resistors have a limited life.

Two types are currently available.

The Type TBR is rated at 2 watts maximum at 50 degrees C ambient, 15,000 volts, 1 megohm to 10 megohms. The Type TFQ is rated at 3 watts maximum at 50 degrees C ambient, 20,000 volts, 1 megohm to 10 megohms.

A data sheet covering these new resistors is available from the company on request.

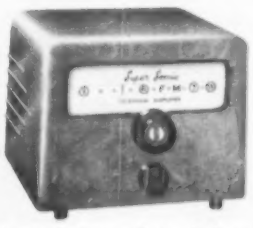
TV/FM AMPLIFIER

Sonic Industries, Inc. of 221 West 17 Street, New York, New York has announced the addition of a TV/FM amplifier, the Model IT 5, to its line.

The amplifier is designed to provide high gain preselection for any video or FM receiver, with adequate bandwidth to pass all desired modulating elements yet with adequate selectivity to reject unwanted off-carrier signals and noise.

Tuning is accomplished with one continuous tuning control and one "on-off" switch. The unit uses no verniers or high-low switching units. Electrical efficiencies have been obtained by means of pure silver inductances and r.f. circuit contacts, minimum shunt grid and plate circuit capacities, short input and output link wiring, optimum input and output link circuit coupling, high quality insulating elements, copper-plated chassis, and heavy power supply filtering.

The amplifier is housed in a walnut



bakelite cabinet and is designed to match both 72 ohm and 300 ohm input and output circuits above the power line system.

TELEVISION BOOSTER

The "Tune-O-Matic," a new high-gain, self-tuning television booster with an all-channel broadband circuit and four-stage amplification is now being marketed by *Electro-Voice, Inc.* of Buchanan, Michigan.

The new booster may be simply and easily installed. It plugs in between the television receiver and the electric outlet and is turned on or off automatically by the TV receiver switch.

Automatically tuned for all channels, 2 through 13, the new booster instantly supplies extra signal strength uniformly throughout any channel selected on the TV receiver dial. It is not necessary to switch from low to high bands. Regulation of gain is made by turning the receiver contrast

"Premier" Values on PARTS and TUBES

Output Transformers

STANDARD REPLACEMENT

For 50L6, 35L6, 50A5, 35A5, 117L7 — **47c** ea.

For 6V6, 6F6, 3Q5, 3Q4, 1S4, 1V4, 41, 42, 6K6, 2A3, 45, 6L6 — **54c** ea.

UNIVERSAL OUTPUT TRANSFORMERS SPECIAL

Up to 12 watts to any speaker (while they last) ea. **$1.18**

World's Best Indoor TV Antenna

A beautiful antenna which is the ultimate in reception, highest signal gain, nothing to adjust.

List price $12.00. Each **$4.78**

TV Antennas:

Hi-Low Conical with 8-ft. mast **$5.94**

World's Best Deluxe Conical

with 9-ft. mast and heavy cast fittings 10.74

Hi-Low folded dipole array, 8-ft. mast 8.34

Ballast Tubes for AC-DC TV Sets ea. .60

TV Discrimi-nator Transformers ea. .83

TV Screen Filters with suction cups—best quality INDIVIDUALLY BOXED for highest re-sale value — 10" 1.40; 12" 2.34; 16" 3.06

VOLUME CONTROLS

VERY BEST BRANDS	10 or more Each	Price Each
½ meg. or 1 meg. or 1 10 meg. with switch—long shaft	35c	42c
2 meg. for battery sets—switch, long shaft	35c	42c
½ meg., 1 meg., 1 10 meg. or 2 meg., long shaft, less switch	19c	23c
1000 ohm	19c	23c
5000 ohm	19c	23c
½ meg. with 6" shaft	59c	71c

Oscillator Coils for any 5-tube AC-DC **23c**

Standard replacement crystal cartridge L70-L72 NYLON 13 CARTRIDGE **$1.96** $2.59

IF TRANSFORMERS

Standard Replacement
Regular size 455 Kc ea. **35c**
Midget 455 Kc ea. 47c

FILTER CONDENSERS

Very best brands. Fresh stock

450 Working Volts		150 Working Volts	
8—450 V	ea. 29c	8—150 V	ea. 23c
10—450 V	ea. 35c	8 8—150 V	ea. 23c
20—450 V	ea. 47c	10—150 V	ea. 23c
30—450 V	ea. 59c	10-10—150 V	ea. 29c
30—450 V w/ 20-20—25 V	ea. 35c	10-10-10—150 V	ea. 35c
10-10—450 V	ea. 52c	15—150 V	ea. 25c
20-20—450 V	ea. 59c	20—150 V	ea. 30c
10-10-10-20—450V-150-25 V	ea. 59c	30—150 V	ea. 35c
30-30—400 V-350 V	ea. 47c	40—150 V	ea. 35c
30-30-25—400 V-25 V	ea. 47c	15-15—150 V	ea. 35c
		20-10—150 V	ea. 35c
		20-20—150 V	ea. 35c
		30-20—150 V	ea. 47c
		30-30—150 V	ea. 47c
		35-35—150 V	ea. 47c
		40-20—150 V	ea. 47c
		40-40—150 V	ea. 47c

40-40—150 V	ea. 47c
20-25 V	ea. 47c
50-30—150 V	ea. 47c
20-16-16—350 V Sprague type	ea. 47c
25-25—150 V-200-10 V	ea. 47c
15-15-40-20—150 V-25 V	ea. 35c
20-20—150 V-25 V	ea. 47c
30-30-200—150 V-10 V	ea. 47c
20-16-16—150 V	ea. 47c

Cathode Condensers

10-25 V; 20-20—25 V; 20-20-20—25 V; 30-50 V; 100—25 V — **19c** ea. — 25c ea.

SPEAKERS

Best Quality Alnico 5 PM

	10 or more Each	Price Each
2½", 3", 4", 5"	**1.14**	**1.26**
8"	$2.94	$3.23
10"	4.74	5.10
12"	5.94	6.54

SPECIAL—6" PM Speakers, big Alnico 5 magnet, in lots of 10, each $1.55
individual 1.67

SPECIAL—CONDENSER KITS

Kit of 50 BY-PASS CONDENSERS very best, assorted sizes **$1.98**

SELENIUM RECTIFIERS
Standard 100 mil. Ea. **95c**

Special on No. 47, 44 and 51 100 Pilot Lights $4.74
Box of 10 59c

PILOT LIGHTS—100 Bulbs $5.88
Box of 10 Bulbs 65c
No. 40 No. 41 No. 46

OCTAL SOCKETS MOLDED 10 for 59c

7-PIN MINIATURE SOCKETS 10 for 59c
9-Pin Miniature Sockets 10 for 59c
Loctal Sockets 10 for 59c

300 ohm twin lead
1000 ft. rolls $29.00
100 ft. rolls $3.25

BY-PASS CONDENSERS

100 Condensers assorted in package **$7.14**

.001	6c	.0005	
.002	6c	.00025	
.005	6c	.0005	
.01 600 V.	8c	500 mmf	7c
.02	8c	250 mmf 600 V.	
.05	10c	100 mmf MICA	
.1	11c	50 mmf	

BYPASS SPECIAL—SOLAR
In lots of 25 or more ea. 11c
.25 mfd. 600 V. Less than 25 ea. 14c

400-VOLT BY-PASS CONDENSERS

.05 mfd. ea. 7c
.2 mfd. ea. 7c
.25 mfd. ea. 12c
.5 mfd. ea. 18c

BUFFER CONDENSERS

.005 mfd. 1600 WV
.008 mfd. 1600 WV — ea. **18c**
.01 mfd. 1600 WV

VARIABLE CONDENSERS

Two-gang for superhet or TRF ea. **83c**

RED HOT VIBRATOR SPECIAL!

Standard small size, 2½" in height (the popular small size), bright and shiny, **$1.29**
Stock up while they last, all 4-prong each
Universal Vibrators.

6-FT. LINE CORDS

Good Rubber with plug 10 for **$1.50**
Underwriters' Approved, 10 for **$2.03**

SPECIALS

10BP4 $14.95 | **12LP4 $19.95** | **14BP4 $22.95** | **16RP4 $29.95** | **16TP4 $29.95**

39c ea.

1S5	10	112A	1A4	1D8GT	1H4G
2C26	12A	182B	1A4P	1F4	1H6GT
2C34	39 44	183	1A6	1F5G	1J6G
3A4	47	2S5	1B5	1G4GT	1619
01A	50	482B	1D5GT	1G6GT	1626
6A3	71A	483	1D7		

69c ea.

1T4	25Z6GY	35	VT-52	89	
5Y3GT	30	35Z4GT	56	HY-615	
35W4	31	36	57		
35Z5GT	32	37	58		
6C4	33	38	76		
6X5GT	34	46	80		

89c ea.

3Q4		6AQ5	6BH6	6K7GT	6SQ7GT	12AX7	12SH7GT	35Z6GT
3S4		6AQ6	6BJ6	6K8GT	6SR7	12BA6	12SR7GT	50B5
3V4		6ARS	6C5	6L5	6U6GT	12BE6	1629 eye	50C5
1C5	5W4GT	6AS5	6C8G	6S4	6U7	12F5GT	24A	50Y6
1C6	5X4G	6AT6	6D6	6SA7GT	6V6GT	12H6	25L6GT	51
1L4	5Y4G	6AU6	6F5GT	6SC7GT	6W4	12J5GT	25W4GT	77
1P5	6AB4	6A8GT	6F6GT	6SG7GT	6X4	12J7GT	25X6	78
1U4	6AC4	6B6	6G6	6SH7	6Z4	12K7GT	26	85
1U5	6AC5GT	6BA6	6H6GT	6SJ7GT	12A8GT	12K8GT	27	99
2A5	6AG5	6BD6	6J5GT	6SK7GT	12AT6	12SF5	35B5	
2A7	6AL6	6BE6	6J7GT		12AU6	12SF7	35C5	

98c ea.

1C7G	5V4	6AV6	6J6	6S57	7A6	7E6	7Q7	12AU7	12SG7	20	53
1LA4	5Z3	6B4G	6K5	6SU7	7A7	7E7	7S7	12AV6	12SH7	35 51	75
1LE3	5Z4	6BA7	6P5GT	6Q7GT	7B5	7F7	7T7	12BA7	12SJ7GT	35L6GT	84 6Z4
1Q5GT	6A8	6B8	6R7	6T7G	7B6	7G7	7V7	12BF6	12SK7GT	40	117Z3
1T5GT	6AC7	6C6	6S8GT	6W7G	7B8	7H7	7W7	12C8	12SL7	41	VR150
1V	6AJ5	6CB6	6SF5GT	6Y6G	7C4	7J7	7Y4	12J5	12SN7GT	42	XXL
OZ4 1A7GT	2B7	6AK6	6D8G	6SL7GT	6Z7G	7C6	7L7	12A7	12Q7GT	12SQ7GT	43
1A5GT 1C5GT	5U4G	6AL5	6F8G	6SN7GT	7A4	7E5	7N7	12AT7	12SA7GT	12Z3	50L6GT

$1.10 ea.

1A3	1LC5	1N5GT	3LF4	6J8G	7A8	14A4	14B6	14H7	14X7	35Z3	81
1AB5	1LC6	1P5GT	4A6G	6S7G	7C5	14A5	14B8	14J7	14Y4	45	83
1H5GT	1LD5	1S4	6B7	6SU7GT	12A6	14A7	14E6	14N7	19T8	2050	117Z6GT
1LA6	1LH4	2V3G	6BF6	6T8	12BF6	14AF7	14E7	14Q7	25Z5	2051	9001
1LB4	1LN5	2X2						14W7	35Y4	50C6	XXB

$1.25 ea.

1B3GT	2A4	6AK5	6G5	6U5	70L7GT	6B5	25AC5GT	117L7GT	19BG6G
1X2	3Q5	6BQ6GT	6L6G	12L7GT	350B	**$1.35 ea.**	6BN6	25BQ6GT	117P7GT	**$1.79 ea.**	
2A3	6A7	6E5	6S07GT	50A5	807		12BN6				

Less than 50 tubes, 5c per tube extra.

Tube prices are for 50 tubes or more may be assorted.

Individually boxed Standard factory guarantee.

PREMIER RADIO TUBE COMPANY
551 West Randolph St., Chicago 6, Ill.
Phone: Andover 3-1590
"Your Tube Source Since 1926"

20% deposit with order, balance C.O.D. $1.00 handling charge for orders less than $5.00. All shipments F.O.B. Chicago. Our parts and tubes are warranted to be 100% replacements for the prototypes in the listings above. Satisfaction Guaranteed. Illinois residents add 2% sales tax.

control. No need to retune after the booster warm-up period as signal drift is eliminated.

The four-stage amplification completely isolates the receiver local os-

cillator and effectively eliminates re-radiation which causes interference to nearby TV sets.

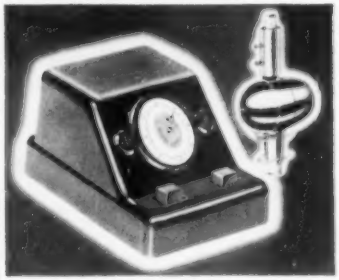
Full information on the new booster is available from the company on request.

COMPASS POINT INDICATOR

U. S. Devices Corporation of Hillside Ave-Oaktree, South Plainfield, New Jersey has a new compass point indicator available for the TV market.

This new unit features a full 360 degree dial which is said to be four times larger and clearer than any other similar indicator currently available. The indicator shows the exact position of the antenna at all times whether the antenna is in motion or stopped. It features a simple mechanism which is foolproof and impervious to varying line voltage.

The rotator features a ¾" steel shaft which rotates on a case-hardened steel ball, in-line ream oilless bearings keep



the shaft in line at all times. The unit is capable of rotating an antenna weighing as much as 1000 pounds.

Complete data on the new indicator is available from the company on request.

HAYDU ROTATOR

Haydu Brothers of Plainfield, New Jersey is currently in production on a new antenna rotator which has been developed after many months of engineering and experimentation.

The new rotator operates from the chairside through a remote control cabinet connected to the motor unit by a three-conductor cable. Rotation is accomplished by pressing either of two buttons, for turning either right or left. Releasing the button instantly stops rotation without coasting and locks reception in that precise posi-

OUTSTANDING VALUES NOW AVAILABLE

G I—13-CHANNEL TELEVISION TUNER

For replacement or construction work. Capacity type tuner with fine tuning control. Using 3—6J6 tubes. Input for 300-ohm line. One of the finest front ends ever built.

Each.....**$6.95** less tubes
Lots of 3..... **6.50** each

VOLUME CONTROL STEAL

250,000 } With switch—2½" milled shaft
500,000 } **39¢** ea.
1 meg. } Lots of 10.....**$3.72**
2 meg. } Asst. of 25..... **8.74**

Standard Type Replacement Phono Cartridge

All New—All Guaranteed

Type No. 1 will replace Shure W58A
Webster N10
Astatic L70

Price—only **$1.85** ea. Lots of 10 **$17.90**

Type No. 2 will replace Shure W56A
Webster N10
Astatic L-72

Price—only **$1.99** ea. Lots of 10 **$18.90**

CERAMICON CONDENSERS

Standard Manufacture

Kit of 100 most often used ceramicons—now only.....**$4.95**

GT TUBE CARTONS

Sturdy—Many Uses.

Box bulk tubes, spare parts, nuts and bolts.
$ .79 per 100
4.95 per 1000

KNOB ASSORTMENT

Includes half push on and half set screw knobs. All used often.

100 knobs only.....**$1.89**

PM REPLACEMENT SPEAKERS ALL NEW—ALL GUARANTEED

4" Alnico V	**$1.19** ea.
5" Alnico V	**1.29** ea.
6" Pin Cushion Alnico V	**1.69** ea.
6" Round Alnico V	**1.69** ea.
4x6" PM Alnico V	**1.59** ea.
7" PM Pin Cushion Heavy Alnico V Offset holes for auto replacement.	**2.29** ea.
6x9" PM Heavy Alnico V	**2.29** ea.
8" PM Heavy Alnico V	**3.25** ea.
10" PM Heavy Alnico V	**3.95** ea.
12" PM Heavy Alnico V	**5.25** ea.

NOW! LARGE 14" or 16" PICTURE FROM YOUR 10" or 12" TELEVISION SET

Servicemen: Convert customers' sets for extra profits! 90% of all conversions can be made by use of the RAPARCO conversion kit.

Includes 14BP4 CR tube, 70° deflection yokes, and attractive lucite mask.

Complete, only.....**$32.95**

HIGHEST QUALITY TELEVISION COMPONENTS AT LOWEST PRICES YET!

Standard Manufacture—All New—All Guaranteed. All these parts are used constantly in repair or conversion work.

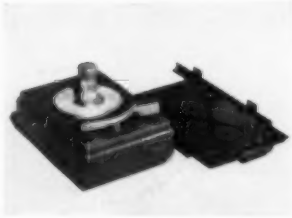
70° Deflection yoke—includes leads and resistors	**$3.50** ea.
60° Deflection yoke	**2.25** ea.
Flyback transformer for 12½" set	**2.75** ea.
Flyback transformer for 16" set	**3.50** ea.
14" Attractive Lucite Square Mask	**3.95** ea.
16" Attractive Lucite Square Mask	**4.50** ea.
14BP4 Square, Black 14" CR tube	**25.95** ea.
16TP4 or 16XP4 Square Black 16" CR tube	**37.50** ea.

INDOOR TELEVISION ANTENNA

Now TV reception without the outdoor antenna. Effective range 20 to 25 miles from station. Excellent reception. Easily installed—takes 5 seconds. Easily orientated. Heavy base—will not tilt. Attractive. Friction clutch-type action on the rods.

Complete with lead in.....**$1.99**

CRESCENT CHANGERS for the RCA 45-R.P.M. System



A complete changer ready for installation or attachment. Beautiful in appearance, built to last under constant service.

Each changer comes complete with Crescent "Rollway" mounting for custom installations.

Price complete.....**$8.59**

Metal Base for RCA 45 R.P.M. changer—Mahogany Hammerloid Finish. **$1.00**

SUPER 25 WATT HI-FI AMPLIFIER KIT

Including all parts, schematic and layout diagrams, enabling you to easily build this fine, deluxe amplifier.

FEATURES:

- **Ready punched chassis**
- **Multi-impedance output transformer 2-4-8-16-500 ohms for use with any PM speaker**
- **2 mike inputs, 1 phono input**
- **Push pull phase inverter driver for low hum and distortion**
- **Hum level 65 DB below rated output**
- **Separate bass and treble control**
- **110-120 volt AC operation, on fuse UL approved line cord**
- **6 tubes: 2—6SJ7, 6SC7, 2—6L6G, 5Y3**
- **Attractive, well-constructed steel chassis and cover. Baked hammerloid finish**
- **Indirect lighted panel**
- **Frequency Response 20-17000**

Nowhere can an amplifier of comparable features be had for twice the price. This amplifier, designed from the famous Clark Amplifier, will fill 90% of all sound uses.

$25.95 COMPLETE WITH TUBES

Radio Parts Company, 614 RANDOLPH ST., CHICAGO 6, ILL.

tion. A signal light is included in the circuit hook-up and glows brightly to indicate the completion of each revolution.

Other features of the new unit include a permanently weather-sealed cast aluminum housing which will withstand pressure up to 33,000 pounds per square inch, a self-protecting feature that prevents accidental damage to the unit through improper operation, operation from any 110 volt a.c. wall outlet, and the use of *Barber-Coleman* gears throughout.

MASCO BOOSTER

Mark Simpson Mfg. Co., Inc. of 32-28 49th Street, Long Island City, N. Y. has announced a new television booster, the *Masco* "Sky Chief."

The new booster is designed for use in areas of low signal strength and to help reduce noise and interference from diathermy, auto ignition, radio and TV sets, amateur transmitters,

and FM stations. It is also said to aid in eliminating ghost images and in reducing snow.

The unit is housed in a baked mahogany metal cabinet with a sloping dial panel. Its one tuning control covers from Channel 2 to Channel 13. It turns itself on with the TV receiver and "stands by" when its additional signal strength is not required.

ROOF MOUNT

Of interest to television installation men is the announcement by *Channel Master Corp.* of Ellenville, New York of a new "All-Angle Peak Mount."

According to the company, the new mount solves all roof mounting problems inasmuch as it will fit all kinds of roofs. It will fasten securely on flat roofs, level or sloping, and peaked roofs of any angle or pitch. Firmly gripped by a rigid U-bolt clamp in the unit's serrated nest, the antenna mast cannot turn even in the strongest winds.

The Model 9015 is a heavy-duty unit, consisting of three massive castings of hard-temper aluminum, alloy 319. It cannot rust or corrode. The mount will accommodate masts from 1" o.d. to 2" o.d.

This new roof mount, as well as the company's other TV accessories, is completely described in a new accessory catalogue which is available on request. —30—

ance of the equalizer (15,000 ohms) to a line impedance of 600 ohms.

The AE-2 unit was panel mounted and may be seen in the photo directly above the jack fields.

Line Amplifier and Bridging Bus

The purpose of a line amplifier is to take a relatively low level signal and bring it up to a suitable level for transmission through a line. The output level of the line amplifier must be sufficiently high so that it may override any noise which is induced in the transmission line. Normally, a suitable figure for this output is plus 4 dbm.

The line amplifier employed in this system raises the input level of approximately minus 30 dbm. to an output level of plus 4 dbm. The over-all gain therefore must be at least 34 db. The design of this line amplifier is conventional and will be treated more fully in later chapters. The output or secondary side of the line amplifier terminates in a low impedance bridging bus.

The bridging bus is a transmission line terminated by a suitable resistor. The function of the bridging bus is to act as a distribution point from which the audio signal may be fed to several other circuits, including bridging amplifiers, metering circuits, monitor amplifiers, recording amplifiers, and long lines. The bridging bus is a low impedance circuit of 600 ohms. The line amplifier therefore works between two low impedances.

The Jack Field

The jack field comprises two panels, namely the *ADC* PJ143 and a PJ141 jack panel. The jack field is really the heart of our system and all input and output circuits terminate in one or the other of the jack strips. Provisions are made for direct connection of the phono pickups, microphones, detector circuits, bridging circuits, monitoring circuits, metering circuits, amplifier circuits, and speaker circuits. It is extremely important when laying out a jack field that all circuits having a difference in level of approximately 20 db. be widely separated in order to prevent crosstalk. This is accomplished by positioning all low level sources remote from output power from the amplifiers. The design of the jack field probably receives the greatest amount of attention in a system such as this. All wiring and cabling must be done with extreme care in order to avoid ground loops. Complete details on the construction of a jack field will appear in later chapters. Suffice it to say that, being of prime importance, it should receive careful consideration.

Recording-Playback Amplifier

Inasmuch as we engage in a considerable amount of disc recording, it was

imperative that a high quality amplifier be used having an undistorted output of at least 50 watts. This requirement was met with the *McIntosh* 50W2 amplifier.

Since an amplifier is an electronic device, passing a wide band of frequencies, it is necessary that the amplifier does not change the characteristics of the signals that are transmitted to it, otherwise the deletion of frequencies and/or high order of intermodulation distortion will result which can be most irritating to the listener. It is not sufficient to talk of gain frequency characteristics alone simply because every good amplifier, with an audio range from 20 to 20,000 cycles, has a variation of less than one db. It is obvious to the experienced engineer that this is a very difficult variation to measure. An amplifier will pass no more peak power per instant than it will power on a continuous basis, usually with the same amount of distortion. Therefore the amplifier must be designed for the maximum peak and for the maximum frequency range it is desirable to pass.

Sacia, back in 1925, showed that the average acoustical power in speech is quite low and that the momentary or instantaneous peaks of speech were found to be 200 times this average power. In music it is found that this ratio may go up from 200 to 400. Therefore we know that an amplifier, or other device, must be able to pass peaks averaging from two hundred to four hundred times the average power in speech or music.

As an example, suppose ¼ watt average electrical power is fed into a loudspeaker (which is about right for monitoring a program). It is evident that from 50 to 100 watts would be required to satisfy the peak powers of the original sound. It may seem somewhat astonishing to realize the sort of powers that are needed for adequate reproduction and recording of speech and music even for home systems. While these peaks are often of very short duration and do not necessarily fatigue the listener, they do chop off at the top. It results in loss of the dramatic nature and thrill of listening to reproduced sound.

With the amplifier efficiencies that are now available (60 to 65%) over the conventional 15 to 20%, it is possible to achieve some of the dynamic power peaks on a practical scale and at a practical cost. It is recommended, therefore, that the basic amplifier used for either recording or reproduction have a power of approximately 50 watts. This amplifier provides a reasonably safe margin and provides for the realistic reproduction of speech and music. Complete details on the design of the amplifier will appear in later chapters.

The 50W2 amplifier is provided with a 600 ohm line input transformer. In order to provide sufficient gain a separate plug-in booster amplifier, especially designed for the unit, was employed. The 600 ohm output of the amplifier normally connects through the jack field to the playback speaker.

The Monitor Amplifier

Our fifth requirement was met by employing a *Radio Craftsmen* RC2 amplifier. An input bridging transformer was added to match the impedance of the bridging bus. The 600 ohm output connects to the jack field and is "normalled" to the monitor speaker. The amplifier provides approximately 10 watts output at low distortion.

The Spare Amplifier

It is always good practice when designing a system to provide a spare record - reproduce - monitor amplifier, should it be needed. This unit is based on the design of *John Goodell* and employs the *Scott* Dynamic Noise Suppressor. It may be seen in the photo in the upper right hand corner of the dual rack assembly. Construction of this amplifier will be treated separately in a later chapter. The input and output circuits of this amplifier terminate in the jack field and the amplifier may be substituted (by means of patching) for any other amplifier in the circuit with perfect impedance match.

The FM-AM Tuner

This unit is the *Radio Craftsmen* RC10 tuner with built-in audio preamplifier. We found it desirable, when laying out this system, to provide emergency preamplification for the several inputs. By employing this new tuner, we were provided with such spare facilities. Normally this tuner connects to the jack field and the detector output of the tuner feeds normally to the input of the AE2 preamp equalizer. When needed, any of the phono pickups or other input sources may be patched in to the RC10 tuner. Here equalization is also provided for the program source as well as provision for complete bass and treble tone control.

The Television Tuner

Inasmuch as the equipment was to be used not only as a recording-reproduce system, but as a television entertainment position, we decided to incorporate our television tuner within the assembly. The tuner used and shown in the photos is the *Radio Craftsmen* RC100A. It is fed by a regular outdoor television antenna and this also serves to provide signals for the FM-AM tuner. A 1000 ohm resistor connects between the antenna terminal of the tuner to one side of the television antenna. This provides the required isolation.

The output of the TV tuner also terminates in the jack panel and from them is normalled to a 2-stage audio amplifier and separate speaker. In this way it is not necessary to operate the entire audio group in order to provide audio amplification for the television tuner when used alone. If a recording is to be made from a TV program source, it is a simple matter to

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R·H·S

SPECIALS OF THE MONTH

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1B27	24.50
1B29	2.75
1B32	1.79
1B36	24.96
1B38	32.50
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1N21A Xtal	1.89
1N21B Xtal	3.25
1N22 Xtal	1.35
1N23 Xtal	1.25
1N23A Xtal	1.75
1N23B Xtal	3.95
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1N34	.95
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2C44	1.49
2C46	7.50
2C51	5.75
2D21	1.25
2E22	1.19
2E24	4.69
2E26	3.69
2E30	2.29
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2J32	12.95
2J33	39.50
2J34	39.50
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350B	1.75
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371B	.65
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446B	1.79
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527	9.75
559	1.39
562	97.50
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702A	2.69
703A	2.39
704A	1.05
705A	.89
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708A	3.59
709A	3.95
710A/8011	.85
713A	.79
714AY	3.52
715A	6.49
715B	6.85
715C	24.50
717A	.69
721A	2.25
722A	2.95
723A	6.75
723A/B	12.95
724B	2.95
725A	6.45
726A	4.95
726B	29.50
726C	49.50
730A	8.95
750TL	79.50
800	1.69
801A	.25
802	4.10
803	3.10
804	9.95
805	3.49
806	29.95
807	1.98
808	1.95
809	2.25
810	9.95

811	$2.49
812	2.85
812H	6.90
813	8.95
814	2.25
815	2.25
816	1.19
826	.98
828	12.75
829	7.45
829B	12.95
830B	3.95
832	4.95
832A	7.95
833A	37.50
836A	1.25
837	1.35
838	2.35
841	.33
843	.27
845	3.75
849	29.50
851	13.95
852	6.25
860	6.95
861	10.95
864	.29
865	1.45
866A	1.15
866JR	1.15
869B	26.50
872A	1.25
874	.89
876	.35
878	1.69
884	1.49
885	1.39
902	5.95
905	2.59
908	7.95
918	1.49
919	1.95
923	.72
927	1.09
930	.89
931A	3.59
954	.29
955	.35
956	.35
957	.35
958	.35
959	.49
991/NE16	.32
1003	1.98
1613	1.25
1614	1.95
1616	.75
1619	.29
1622	1.49
1624	1.25
1625	.35
1626	.35
1629	.25
1630	.98
1631	.85
1632	.79
1633	.69
1634	.75
1636	3.25
1638	.65
1644	.98
1654	2.39
1665	1.25
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0A2
0A4G
0B2
0Z4
01A
1A3
1A4P
1A5GT
1A6
1A7GT
1AB5
1B3/8016
1B4
1B5/25S
1B7GT
1C5GT
1C6
1C7G
1D5GP
1D7G
1D8GT
1E5GT
1E7G
1F4
1F5G
1G4GT
1G6GT
1H4G
1H5GT
1H6GT
1J6GT
1L4
1LA4
1LA6
1LB4
1LC5
1LC6
1LD5
1LE3
1LG5
1LH4
1LN5
1N5GT
1P5GT
1Q5GT
1R4
1R5
1S4
1S5
1T4
1T5GT
1U4
1V
2A3
2A4G
2A5
2A6
2A7
2B7
2V3G
2X2
2X2A
3A4
3A5
3A8
3B7/1291
3D6/1299
3LF4
3Q4
3Q5GT
3S4
3V4
5R4GY
5T4
5U4G
5V4G
5W4
5X4G
5Y3GT
5Y4G
5Z3

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5Z4
6A3
6A4LA
6A6
6A7
6A8
6AB7
6AC5GT
6AC7
6AD7G
6AE6G
6AF6G
6AG5
6AG7
6AH6
6AJ5
6AK5
6AK6
6AL5
6AQ5
6AQ6
6AR5
6AT6
6AU6
6AX6
6B4G
6B6G
6B7
6B8G
6BA6
6BE6
6BF6
6BG6G
6BH6
6BJ6
6C4
6C5
6C6
6C8G
6D6
6D8G
6E5
6F5
6F6
6F6GT
6F7
6F8G
6G6G
6H6
6H6GT
6J5
6J5GT
6J6
6J7
6J7GT
6K5GT
6K6GT
6K7
6K8
6L5G
6L6
6L6G
6L6GA
6L7
6L7G
6N7
6Q7
6R7
6S7G
6S8GT
6SA7
6SC7
6SD7GT
6SF5
6SF5GT
6SF7
6SG7
6SH7
6SJ7
6SK7
6SL7GT

DUE TO THE CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES.

6SN7GT
6SQ7
6SR7GT
6SS7
6ST7
6SU7GTY
6SV7
6T7G
6T8
6U5G
6U6GT
6U7G
6V6
6V6GT
6W4
6W7G
6X4
6X5GT
6Y6G
6Y7G
6Z7G
6ZY5G
7A4/XXL
7A5
7A6
7A7
7A8
7AG7
7B4
7B5
7B6
7B7
7C4
7C5
7C6
7C7
7E5
7E6
7E7
7F7
7H7
7K7
7L7
7N7
7Q7
7R7
7S7
7V7
7W7
7X7
7Y4
7Z4
12A
12A6
12A7
12A8GT
12AH7GT
12AL5
12AT6
12AT7
12AU6
12AU7
12AV6
12BA6
12BE6
12C8
12F5GT
12H6
12J5GT
12J7GT
12K7GT
12K8
12Q7
12SA7GT
12SC7
12SF5
12SF7
12SG7
12SH7

DUE TO THE CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES.

12SJ7
12SK7
12SL7
12SN7
12SQ7
12SR7
12Z3
14A4
14A7
14B6
14F7
14F8
14H7
14J7
14N7
14Q7
14R7
19
24A
25L6GT
25Z5
25Z6GT
26
27
28D7
30
31
32
32L7GT
33
34
35/51
35A5
35B5
35C5
35L6GT
35W4
35Y4
35Z3
35Z4
35Z5
36
37
38
39/44
41
42
43
45
45Z3
45Z5
46
47
48
49
50A5
50B5
50C5
50L6GT
50Y6
53
56
57
58
59
70L7
71A
75
76
77
78
80
82
83
83V
84/6Z4
85
89Y
117L7/M7
117N7
117P7
117Z3
117Z6

DUE TO THE CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES.

SELENIUM RECTIFIERS FULL WAVE BRIDGE TYPE

Input 0-20V AC Type No.	Current	Output 0-14.5V DC Price
20B1	1.2 Amps.	$ 2.49
20C1	2.4 Amps.	3.49
20F1	6.4 Amps.	4.95
20K1	13.0 Amps.	8.95
20J1	17.5 Amps.	11.95
20K2	26.0 Amps.	17.95
20K3	39.0 Amps.	24.95
20K4	52.0 Amps.	29.95
20K5	65.0 Amps.	35.95
0-40v AC	**Current**	**0-34v DC**
40B1	.6 Amps.	$ 2.95
40C1	1.2 Amps.	3.89
40F1	3.2 Amps.	5.25
40K1	6.0 Amps.	9.95
40J1	9.0 Amps.	12.95
40K2	12.0 Amps.	18.95
40J2	18.0 Amps.	22.45
40K4	24.0 Amps.	32.50
40K3	30.0 Amps.	34.95
40J4	36.0 Amps.	39.50
0-120v AC	**Current**	**0-100v DC**
40B1A	.6 Amps.	$ 7.85
40C1A	1.2 Amps.	10.76
40F1A	3.2 Amps.	16.65
40K1A	6.0 Amps.	24.75
40J1A	9.0 Amps.	32.95

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Single Phase Full Wave Bridge

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10C1	2.4 Amps.	2.25
10F1	6.4 Amps.	3.87
10K1	12.0 Amps.	4.95
10J1	16.0 Amps.	7.95
10K2	24.0 Amps.	10.75
10K3	36.0 Amps.	14.75
10K4	48.0 Amps.	17.75
10K5	60.0 Amps.	19.95
10K6	72.0 Amps.	25.57
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10K10	120.0 Amps.	42.50

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625v @ 10 MA; 525-0-525v @ 60 MA; 2x5v @ 3A; 6.3v CT @ 3.6A; 6.3v @ 2A; 6.3v @ 1A	5.55
700-0-700v @ 300 MA	7.55
500-0-500v @ 175 MA	4.55
430-0-430v @ 240 MA; 6.3v CT @ 6.3A; 5v @ 6A	4.85
425-0-425v @ 75 MA; 6.3v @ 1.5A; 5v @ 3A	3.65
415-0-415v @ 60 MA; 5v CT @ 2A; 115/230 Dual Pri	4.97
400-0-400v @ 150 MA; 6.3v CT @ 8½A; 5v @ 3A; 2.5v CT @ 5A	4.35
400-315-0-100-315v @ 200 MA; 2x6.3v @ 9A; 5v @ 3A; 2.5v @ 2A	5.35
500-385-0-385v @ 200 MA; 2x6.3v @ .6A; 5v @ 2A; 2.5v @ 2A	4.75
325-0-325v @ 12 MA; 235-0-235v @ 240 MA	4.25
300-0-300v @ 65 MA; 6.3v @ 2.5A; 6.3v @ 1A; 2x5v @ 2A	3.25
80-0-80v @ 225 MA; 5v @ 2A; 5v @ 4A	2.97
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patch in the output of the tuner into one of the preamplifiers.

The Speaker Lines

Two separate speaker lines are used, one going to a special monitor speaker, the other to the playback speaker. Both are of 600 ohms. Two 8" *Permoflux* speakers (connected in parallel) are used for monitoring, while the playback speaker is the new *Jensen* G610, described elsewhere in this issue.

The Recording Turntables

The turntables are *Presto* 6N units which have been in use for many years at the author's installation. Normally one of the tables is used for disc recording. The recording mechanism has been removed from one table in order to provide space for the mounting of additional phono reproducers for experimental purposes. Shown are two *Pickering* 130M pickups and a *G-E* variable reluctance unit. Another pickup used in this system is the *Audax* Polyphase transcription reproducer.

Magnetic Tape Recorder

The recorder shown in the photos is the *Magnecord* PT6JA. Since taking the photos these have been replaced with the new PT63JA. The 600 ohm output of the *Magnecord* amplifier terminates in the jack panel, as does the signal from the monitoring head. This will be discussed in greater detail in later chapters.

Meter Panel

It is necessary to provide accurate means for measurement of line and power levels. Shown are two *Simpson* Model 49 standard vu. meters. One, with necessary attenuator to extend the range of the instrument is used for power level measurements. The other meter is normally connected to the bridging bus, and audio level is maintained through the line at plus 4 dbm.

It is not possible in this limited amount of space to discuss in detail the many components comprising this system. In later chapters we will deal with each unit separately and discuss its application.

(To be continued)

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RCA Sound System

(*Continued from page 63*)

RCA LC1A loudspeaker mechanism for the frequencies 500, 1000, 3000, 7000, 10,000 and 15,000 cycles are shown in Fig. 11A. The directivity patterns show that the angular spread for a variation of ±3 db. is more than 90° up to 15,000 cycles.

The total r.m.s. distortion frequency characteristic for the LC1A loudspeaker for 1, 2, and 10 watts input is shown in Fig. 4B.

The response frequency characteristic of the 515S1 speaker mechanism mounted in the cabinet of Fig. 14 with port opened and closed are shown in Fig. 15A. The response is uniform from 50 to 12,000 cycles.

The directional characteristics of the *RCA* 515S1 loudspeaker mechanism for the frequencies 500, 1000, 2500, 5000, 7000, and 10,000 cycles are shown in Fig. 11B. The directivity patterns show that the angular spread for a variation of ±3 db. is more than 60° up to 10,000 cycles.

The total r.m.s. distortion frequency characteristic for the 515S1 speaker for 1, 2, and 5 watts input is shown in Fig. 4A.

Record Changer

A new changer and record of complementary design having a rotational speed of 45 r.p.m. has been developed[17] and commercialized. This system provides a disc record and reproducer with wide frequency range, low noise, and low distortion characteristics. The records are 6⅞ inches in diameter. Each record contains up to 5⅓ minutes of playing time. The record changer will handle up to ten records.

The 9JY model of the new record changer is provided with a medium frequency range pickup designed for use with conventional radio receivers and phonographs. A wide range pickup cartridge has also been developed[18] and may be substituted for the conventional pickup for wide frequency range reproduction.[19] The response frequency characteristic of the wide range pickup using a standard test record[20] is shown in Fig. 16B. When playing the 45 r.p.m. records, it is necessary to consider the recording characteristics[20] used in making the records. Taking the recording characteristic into account the response frequency characteristic of the 45 r.p.m. record and the wide range pickup is shown in Fig. 16A.

Over-All System

A photograph of the complete system, including the 9JY record changer, amplifier, *RCA* LC1A loudspeaker, and cabinet is shown in Fig. 1. In order to achieve accurate reproduction of the

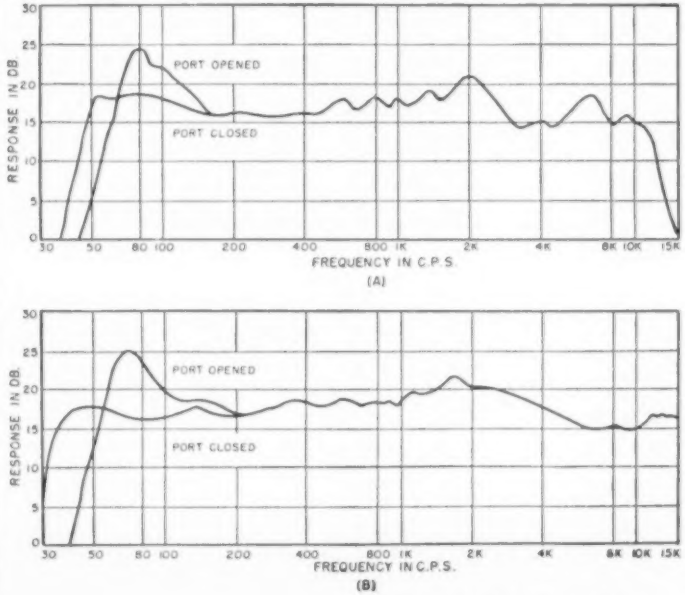
[16] Carson, Burt and Reiskind; "RCA Review," Vol. 10, No. 2, page 173, 1949.

[18] The wide range pickup cartridge RCA Stock No. 74925 was developed by A. D. Burt, RCA Victor Division of RCA.

[19] In order to realize the full high frequency response of the wide range cartridge, it is necessary to remove the volume control from the 9JY changer and to use the shortest possible length of low capacity cable between the cartridge and the amplifier.

[17] Carson, Burt and Reiskind; "RCA Review," Figs. 12 and 11 respectively.

Fig. 15. (A) Response frequency characteristics of the RCA 515S1 loudspeaker mechanism mounted in the cabinet (Fig. 14) with port opened and closed. (B) LC1A response.



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This brand new set of big name manufacture comes complete with battery, battery tray, and handset but less crystal **$89.50**
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SCR 522 Transceiver 100 to 150 MC.	34.95	75.00
MN 26 C	17.50	24.95
RA 10 DA Receiver	17.50	24.95
RT7 APN1 Transceiver	6.95	9.95
APN 1 Complete		24.50
BD 71 6 Pos. Switchboard	9.95	12.95
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BC 347 Interphone Amplifier		2.95
I-70 Tuning Meter		.89
BC 461 Veeder Root Counter		.59
BC 442 Less Condenser	1.49	1.95
APS 13 UHF Antenna, Pair		.98
FL 8 Filter		2.95
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MD-22-URA T1 Radar Modulator
AN APR1 Receiver and Tuning Units
ASB7 Complete Radar Installation

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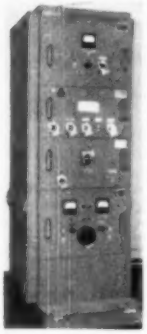

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AN-82B Antenna system
FL-25 Wave Trap
MC-277 ⅞ inch, 70 ohm air dialectric concentric line for transmission
BC-773 Control Box
BC-783 B Amplifier
M-349 Air Compressor
M-348 Oven (dehydrator)
BC-771 Frequency meter
TM 11-1113B Technical manual

This equipment may be purchased as a unit or any component separately. Prices will be furnished on request.

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Receiver—Good. Used **$24.95**

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Set of 5 tubes **$3.95**
Tuning units are available separately at Ea. **$2.50**

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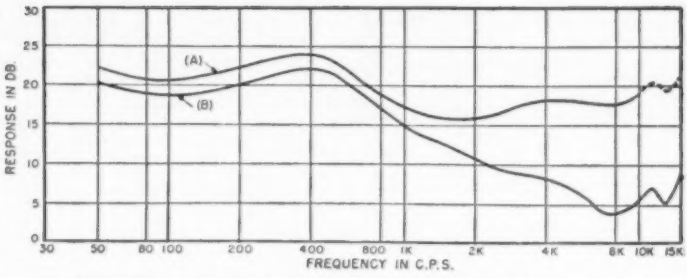


Fig. 16. (A) Response frequency characteristic of the wide-range pickup combined with recording response frequency characteristic. (B) With a standard test record.

45 r.p.m. records with the complete system, it is necessary to provide a small amount of frequency response compensation in the amplifier.

The potentiometer or volume control in the record player should be disconnected and the output of the crystal pickup connected directly to the amplifier through low capacity cable.

The needed compensation is achieved by resistors R_1 and R_2 in combination with condenser C_1. For the LC1A loudspeaker R_1 and R_2 are each 510,000 ohms and C_1 is 50 $\mu\mu$fd. For the 515S1 loudspeaker R_1 and R_2 are each 270,000 ohms and C_1 is 300 $\mu\mu$fd.

Using the proper compensation the over-all response frequency characteristic of the system using the *RCA* LC1A loudspeaker is shown in Fig. 17 as is the over-all response frequency characteristic using the *RCA* 515S1 loudspeaker.

Tanglewood Demonstrations

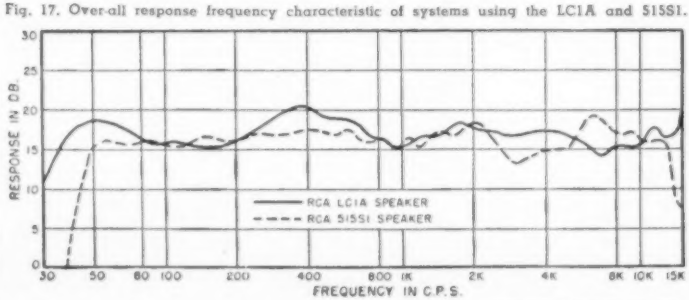
The Festival Series of *RCA* radio, phonograph and television instruments (mentioned in Footnote 7) were first shown and demonstrated at Tanglewood, Massachusetts on July 29, 1947. In order to demonstrate the fidelity of these instruments, the reproduction of the instrument was compared with the full symphony orchestra. The Shed at Tanglewood in which the demonstration was conducted is an immense structure being 239 feet in length, 200 feet in width at the rear, and 40 feet in height. The microphones for recording the sound were located at the front of the stage. When the recording was made, the sound level was measured in various portions of the Shed, so that the level of the reproduced sound would match the sound produced by the orchestra. A record was made of a piece played by the Boston Symphony Orchestra. Twelve *RCA* LC1A loudspeakers, placed at the front of the stage, were used to reproduce the orchestra. In the demonstration, the Boston Symphony Orchestra played the first portion of the selection and then, suddenly the switch to the record was made without interruption in the music and the remainder of the selection was reproduced. Dozens of music critics from several large cities stated in their newspaper and magazine columns that it was scarcely apparent where the live orchestra left off and the reproduced music began. This was due to the fact that the instruments reproduced both the tonal and volume ranges of the orchestra. The frequency range of reproduction was 30 to 15,000 cycles. With the twelve *RCA* LC1A loudspeakers, these tests showed that it was possible to duplicate the frequency and volume ranges of the orchestra.

New Speaker Model

Since the preparation of this article, continued engineering work on the application of the duo-cone principle has resulted in improvements in the design and manufacture of duo-cone speakers. A new model, the *RCA* 515S2, incorporating these improvements has been announced recently by the Tube Department of *Radio Corporation of America*. The amplifier and compensation for the *RCA* duo-cone loudspeaker 515S1 described in this article also applies to the *RCA* duo-cone loudspeaker 515S2.

—30—

Fig. 17. Over-all response frequency characteristic of systems using the LC1A and 515S1.



was necessary because of short leads—was grounded to the bus at one end only and the shield was insulated from the chassis with Scotch tape at any point where it was likely to touch.

The large cathode condenser in the first stage of the playback amplifier was also a hum minimizing measure. The main source of hum at this point is emission from the heater of the tube. The use of a large condenser here helps bypass this source of hum to ground. The filament circuit was shunted by a 20 ohm center-tapped resistor and the center tap was grounded to the bus. In some cases the same result can be had by grounding the center tap of the filament winding, but often the use of the resistor gives closer control of hum.

It will be noted that the filaments of the recording channel and the plate supply for this channel are disconnected through a d.p.s.t. switch when that channel is not in use. This eliminates a heavy load on the power transformer and lowers the heat generated in the amplifier when only one channel is needed. A separate pilot light is used for each channel so that one can tell at a glance whether or not each channel is on.

Operation

The operation of the completed amplifier is very simple. The output from the recording channel is connected to the recording head; the playback head is connected to the input of the play channel and the microphone and phono to their respective inputs. If it is desired to monitor the recorded material right from the tape, all that is necessary is to turn up the playback volume control while the recording process is going on. Adjustment is usually made most easily if an audio oscillator is available. If not, a radio tuner may be connected and the adjustments made "by ear."

Some power transformers give output voltages considerably in excess of that expected. With the playback amplifier in operation, the plate voltage on the 6V6's should not exceed 300 volts. If the voltage is in excess of this value, a 10 watt resistor should be added in series with the lead to the center tap of the output transformer. Usually the proper resistor will be about 1000 ohms. The center tap of the output transformer should be bypassed to ground by means of a 10 μfd., 450 volt electrolytic condenser if this resistor is used.

First, the proper recording level should be determined by experiment. It will be that level at which the recorded signal is considerably above the background noise on the tape, but at which there is a minimum of distortion. The volume indicator needle should swing about ¾ scale at this level. If it does not, R_{10} should be

changed until this condition is brought about.

Next, bias intensity should be checked. Record a portion of tape and rewind it. Then run part of the recorded tape through the machine again with the machine turned on, but with the volume controls at the "off" position. Then play back the whole section of tape on which this trial run was made. If the bias voltage is correct, the portion of tape which was run through the second time will have the high frequencies partly erased, but the signal will be quite strong. If the signal is greatly diminished, the bias is too high and C_B should be replaced with a smaller size.

Different heads have different frequency responses, and it may be necessary to adjust the equalizing circuits, as mentioned earlier, to compensate for the differences in different heads. The values given here worked out very nicely for the *Indiana Model* TD-704 record-playback head, available from the *Indiana Steel Products Co.*, Chicago 6, Ill.

It should be noted at this point that if the experimenter is using two heads —a separate recording and playback head—it is necessary to have some sort of "azimuth control." That is, provision must be made to turn the heads so that the gaps in the two are exactly parallel. If these gaps do not cut the tape at exactly the same angle there will be loss of highs. Usually it is most convenient to have the recording head stationary while the playback head can be tilted until the proper adjustment is made. This can be done very nicely by monitoring as you are recording and adjusting the playback head for best high frequency response.

This amplifier was designed principally for high impedance tape heads, but it will be noted that the oscillator coil has a low impedance winding which will supply bias to a low impedance head while audio can be supplied to such a head through an output transformer. This makes the amplifier easily adaptable for use with low impedance heads.

No erase voltage is supplied by this amplifier, the author having planned to use PM magnet erase which is simple and gives very good results with today's high quality tapes. However, erase voltage may be obtained by adding an amplifier stage following the oscillator, or by utilizing the voltage from the low impedance winding of the oscillator coil, depending upon the type of erase head used.

The unit is housed in a cabinet made of ½" plywood, fastened together with screws, and covered with a plastic covering similar to that used on luggage. The back is left open for ventilation and small rubber feet placed on the bottom eliminate the possibility of scratching any surface upon which the amplifier may be set.

The experimenter will find that this amplifier will give high-quality amplification at moderate cost. —30—

What's New in Radio

(*Continued from page 102*)

eye, and pilot bulbs. There is a spare socket provided in order to accommodate future design tubes. The tester also has an illuminated gear-driven "Speed Roll-Chart," two grid caps, a

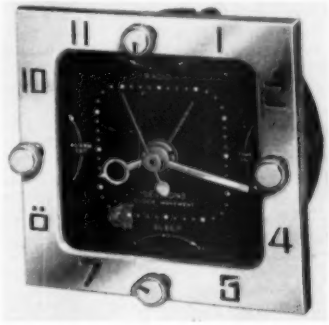
protective overload bulb, a vacuum tube rectifier, and a full-vision bakelite-cased meter.

The kit comes with all the required components and complete, simplified assembly and operational instructions. The display case is available separately or the entire unit is available factory-wired as the Model 625-C.

SWITCH TIMER

A new electric switch timer for radio and television set installations is currently being offered to the trade by *The Sessions Clock Company* of Forestville, Conn.

The new unit has a square bezel of polished brass with color-filled etched numerals. The bezels have been made



to meet a specific need for square design in TV and radio clock combinations.

For complete information on this new line write Department 16 of the Timer Division of the company.

NEW SOLDERING GUN

Weller Electric Corp. of Easton, Pennsylvania, has developed a new soldering gun which is equipped with dual spotlights to eliminate shadows and over/under terminals to brace the tip and improve visibility.

This new model is considerably

YOU'LL THANK US AGAIN AND AGAIN FOR THESE WONDERFUL BARGAIN VALUES

STROMBERG CARLSON—Power Switching Relay Box. Neat 3½x4x5½" Steel case with tight fitting cover finished in Stromberg's usual beautiful chocolate color crackle finish—25c.

CONICAL ANTENNA

Listed model for use coaxial with reflectors. Better on every band, but supersonic in good locale on higher channels. Such locales usually require coaxial antenna. $6.95 each. In lots of 10 $60.00. Order 2C401.

FOLDED DIPOLE ANTENNA

Full size folded dipole with reflector and mast. Stand-off insulators included. $6.75 complete. 10 for $60.00. Order 2C410.

WE CAN MAKE IMMEDIATE DELIVERY ON THE FOLLOWING TUBE TYPES IN REASONABLE QUANTITIES.

2A5	$1.10	6J5	$0.90	12SL7	$1.40
2X2	1.50	6J6	1.74	26	.80
5V4	1.44	6K6	.99	27	.80
5Y3	.75	6K7	.99	32L7	1.50
5Z3	1.08	6L6	1.60	50	1.25
6AC7	1.74	6R7	1.59	56	.85
6AJ5	2.34	6SA7	.99	76	.89
6AK5	2.34	6SC7	1.20	77	.89
6AK6	1.44	6SD7	1.40	78	.80
6B7	1.50	6SF5	.90	80	.69
6C4	.80	6SK7	.80	84	.90
6C6	1.20	6SQ7	.75	85	1.05
6D6	.99	10 or 210	1.25	117L7	2.34
6F7	1.73	12AT6	.90	9GP7—9" scope or picture tube	$7.95

Many of the above are JAN tubes. Manufacturers quantities on some of the above. No price reduction while present shortage lasts.

SCR-522

SCR 522 Transmitter Receiver, approved by Government for ham-ah use and other operation by unlicensed personnel.

Special $75.00

New PE-73 dynamotors to run the above 29.50

PE-94 dynamotors to run same, only 10.00

All Purpose Neon Tester

60 to 550 volt. Indicate all kinds of current. AC, DC or RF, and colors combined with 32-page instruction booklet outlining various tests on radio sets, including the location of failing, dead stages, shorts, and making screen grid and plate circuit tests. 35c ea. Per doz. on attractive display card—$3.50.

SPAGHETTI

Terrific Bargain in Spaghetti at lower than carload lot prices.

Plastic Spaghetti made to U. S. Air Force Spec. Safe for 10,000 volts.

3/32" to 1/8" diam.	10 per ft.
5/32" to 3/16" diam.	15 per ft.
7/32" to 1/4" diam.	25 per ft.
1"	100 per ft.

We can supply continuous lengths up to 100' clear or black in most sizes.

WINDOW ANTENNA

Highest quality telescoping folded dipole antenna, with all the features usually required in such an antenna, including use as a dipole and folded dipole, and additional matching bracket provided so that the antenna can be installed in any window in two minutes or less. Any slight loss in performance due to reduction from rooftop height is more than compensated by ability to orient antenna instantly by opening window. All adjustments for optimal signal strength. Mounting hardware included for horizontal or vertically in window frame or even between sash and screen. Complete with mast. Your cost $7.00. With high frequency attachment for channels 7 to 13 (174 to 216 mc) $9.00. Either type 10% less in dozen lots.

SUPER SCOOP

All Rider Manuals and other Rider Publications 20% off the regular wholesales prices while quantities last.

The Radio Amateur's Handbook

(The Biggest Bargain in Radio Literature)

24th Edition $1.00 25th Edition $1.50
35th Edition, 1.25 27th Edition, 2.00

LINE FILTERS

TYPE "A"—Each unit contains two 4 MFD oil filled condensers and a high inductance choke in a heavy duty steel case. Suitable heavy current connectors are provided to attach to the input and output connectors at each end of the filter from your input and output wires. A filter unit should be used on oil burners, refrigerators, heats, automobiles and wherever noise is to be suppressed or interference abolished. A $17.00 value for $2.98.

TYPE "B"—Heavy duty line filter consisting of 2 condensers and R. F. choke in sealed steel case. Conservatively rated at 4 amps and 600 volts. Perfect for refrigerators, oil burners, power supply input of signal generators or to block on almost any interference you can think of. Super special $3.75 each or 10 for **$5.00**

SPLATTER CHOKES

These Tuned "Splatter Chokes" are used between Class C amplifier and Modulator to eliminate objectionable audio harmonics. In resistance to ground. Order Part No. 2C1, $1.00.

MIKE Jr.

60c

LAPEL MIKES—

(Specify whether carbon or magnetic) 95c

TWIN LINE

We will supply our stores customers with new 72 ohm twin lead at $20.00 per M or $2.50 per C (price subject to change with the issuance of a new line of 100' per antenna purchased).

21 STRAND CABLE

Stranded for flexibility. Stranded core of a MIRACORD cable. 300 lb. test. 21 strands, overall diam. 3/32". Each strand wire of the 21 strands will resist snarling. Also brass plated to resist corrosion. Ideal for antenna guy wires, control cables, trolley wire, etc. 6 cables stranded together to form one 1/4" cable. Will support a 1600 lb. test load. Will not kink or snarl. Sold in 1000 ft. lengths only. $2.50. 5000 ft. spool $10.00.

FCC AUTHORIZES RADIO FOR PRIVATE SERVICE!

In the "citizen's" band neither code test nor license is required. Use this brand new General Electric 15 Tube 3-transmitter-receiver to talk to your friends. Just connect to 117V AC for operation from the instructions and the power supplied will operate a radius of 5 miles. Complete with antenna, ready to operate, nothing to add. For a new dependable, exactly as originally sold for $149.95. FREE literature, order on approval. 2J21 for only $29.95 or 2 for $51.90.

DELUXE AC-DC RADIO KIT

High quality 5 tube superhet broadcast receiver kit. Uses latest miniature tubes in 3 band circuit. Tuning range 540 to 1720 kc. Complete with all parts, tubes, cabinet, etc. No other parts required. Assembles in a few hours regardless of prior experience. Instructions are so simple a child can follow them. Polished walnut plastic cabinet with gold trim. Measures 10"x6"x6". Operates from 105-125 volts AC/DC. Shipping weight 12 lbs. Order 2J400. $8.75 each. 2 for $17.00. Assembled, tested and beamed $12.95 or 2 for $25.00.

COMPRESSED AIR INSTANTLY ANYWHERE

Portable Air Compressor for use on farm, home, garage, etc. Built-in motor. Ball Main Bearing. Lifetime lubricated ball bearing motor. Automatic pressure control and oil-impregnated main bearing for quiet operation. Compact design, lower cylinder is water cooled, the most compact unit of its size available.

PATENTED unique valve system gives increased efficiency and greater capacity than that of motor is much greater than that from larger compressors of heavier motors. Delivers approximately 2500 cu. inches of free air per minute. Pressure switch cuts in at 30 lbs., or will inflate a tire to 30 lbs. from a dead start. Will run continuously at 60 lbs. pressure. Complete with 25 ft. of heavy duty rubber hose, pressure gauge, blow gun, and 6 assorted nozzles for all sizes of tires, as well as for cleaning parts, etc. Will not overheat. Easy to maintain. Weighs 30 lbs. Price $14.50 postage prepaid anywhere in the U. S. Attached unit operated from 6 volt battery of car. Complete with 12 ft. of 3/16 in. heated hose only $7.75 with pilot connector, postage prepaid.

TRANSFORMERS

AUTO TRANSFORMER—Steps up 110v. or steps down 220v to 110v—$2.95.

FIL TRANSF—6.3 V. 1 Amp—$1.00. Universal output transf. 3.5 watts—85c. Wafer Mtg.—$1.29. Watt—$1.99. AUDIO TRANSFORMER—Tube to P.P. Grids—79c. Tube to P.P. Grids—79c. Door Bell Chime All of R. F. purpose—$1.49. Midget transf. 6 V. DC input—$1.49. MIKE TRANSFORMER—Universal output transformer, similar to PTC mixture—$2.00. Midget—98c or DB tube to line—$1.95.

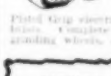
POWER TRANSFORMERS—Half shell type. 110V. 60 cy. Center-tapped HV winding. Specs: either 2.5 or 6.3V filament winding.

For 4-5 tube sets—450V, 40MA, 5V & 2.5 or 6.3V	$1.75
For 5-6 tube sets—450V, 45MA, 5V & 2.5 or 6.3V	1.90
For 6-7 tube sets—475V, 50MA, 5V & 2.5 or two 2.5V	2.35
For 7-8 tube sets—700V, 70MA, 5V & 6.3 or two 2.5V	3.00
For 7-8 tube sets—700V, 70MA, 5V & 6.3 25 Cycles	4.50
For 8-9 tube sets—700V, 90MA, 5V & 2.5-2.5A, 2.5-10.5A	3.50
For 9-11 tube sets—700V, 5V & 6.3V-4A	3.50
For 9-15 tube sets—600V, 150MA, 5V&6.3V	4.00

WE WILL PAY CASH

for RADIO TUBES and for SCR284, BC654, PE103, BC348, BC312, BC222, BC324, and BC342 receivers. SCR522 and BC610 transmitters. We are especially interested in any factory, dealer or other outlet submitting a list of surplus electronic equipment for us to bid on.

Drillmaster Electric Drill



A Terrific Christmas Gift. (But our stock won't last until Christmas.)

Pistol grip electric drill, ideal for hobbyist. Complete with sander, buffing, grinding wheels, etc. $9.95

SIGNAL GENERATOR

Genuine Laboratory-type portable signal generator. Manufactured and used for use on each in large quantities during the war by Northeastern Electronics Corp., one of the top manufacturers of electronic equipment for the U. S. Govt. Five bands—metal bands starting at 150 kc. Strong harmonics up to 120 Mc. Fine step ladder type attenuator as well as vernier. Output control. Beautifully constructed, with 2 tube audio to liquid tube vacuum tube, but a cheap neon sustaining audio oscillator. Audio output jacks available externally. Weight without packing material 10 lbs. which should give what a world of difference exists between this signal generator and the ordinary cheap portable used by the average serviceman. Complete with lined pigskin carrying case. Super Special $16.75.

HEAT GUN

Streamlined pistol grip heat gun. Vivid red housing. 20 cubic feet per minute blast of hot air at 100° Fahrenheit. Ordinary heaters have small fan motors, but this has a lifetime-lubricated AC-DC motor of the rugged vacuum cleaner type, that exhales a hurricane of either hot or cold air. Blow out dirt or dust from radio chassis. Dry out moisture systems. Heat substitute. Quick-dry paint. Thaw out radiators and frozen pipes. Warms baby's bottle when mom can't. She will use it to dry her hair because it will do it in half the time of her ordinary hair dryer. Is not nothing for dry cleaning or defrosting the refrigerator instantly. Only $12.95. Satisfaction guaranteed or money refunded if returned prepaid within 5 days.

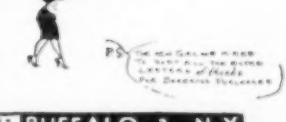
ASSORTMENTS

Wire Wound Resistors, 10 Asst., including 5 watts	$1.00
Knobs, Assorted, 25	1.00
Sockets, 9, 8, 7, 6, 5 prong, 25 for	1.70
Coil Forms, all sizes, 20 Asst. for	1.00
Rotary Switches, Asst., 6 for	1.50
Resistors, Asst., 100 for	3.95
Insulators, Asst., 20 for	1.00
Barkelite Oil 4 Condensers, Asst., 5 for	1.00
Solder Lugs, Asst. Types, 500 for	1.00
Asst. Oscillator Coils, 7 for	1.00
Asst. Turret, Push-button & Slide Switches, $5.00 value, 5 for	1.00

CONDENSERS

Below is designated the quantity of nationally known tubular condensers that you can buy for a DOLLAR BILL.

*.0005-15 *.001, .002 or .005-11 *.01, .02 or .03-10 *.05-9 *.1-8 *.25-6 *.5-4.



BUFFALO RADIO SUPPLY, 219-221 Genesee St., Dept. RN-11, BUFFALO 3, N.Y.

smaller and lighter than previous models and has been designed specifically for radio and TV technicians, electricians, laboratory workers, etc. The gun features dual heat (100/135 watts) for all light and delicate soldering, 5-second heating to save time and current, a trigger-switch control which adjusts the heat to the work and eliminates the need for unplugging the gun between jobs, and a chisel-shaped tip for faster heat transfer and speedier soldering.

Additional details in the form of a catalogue bulletin on the Model WD-135 are available on request.

CABLE TACKER

Especially designed for radio technicians, sound men, and juke box installers, the *Phillips Manufacturing Company* of Minneapolis, Minnesota, has recently introduced a cable tacker which may be operated with one hand.

Featuring concave center guides that instantly center both small and large cables, the new tacker securely and neatly anchors cables without damage to insulation. The unit handles staples of three different lengths (⅜", ½", and 9/16") and the amount of pressure applied to the tacker governs the depth to which the staples are driven. The tacker will handle from single conductor cables up to 30-wire multi-conductor cables of ½" o.d.

50-WATT MOBILE UNIT

A new 50-watt mobile combination for use in the 148-174 mc. band has been announced by the *General Electric Company's* Commercial Equipment Division, Syracuse, New York.

Designated the Mobile Combination 204, the new unit features a low cost tube complement, easily adjustable tuned circuits having triple-tuned transformers, and a new built-in low

pass harmonic filter in the antenna output circuit which attenuates harmonics at least 70 db.

The receiver circuit elements provide better than 100 db. adjacent chan-

nel selectivity. Standby battery drain for the new unit is 11 amps. at 6.3 volts and transmitter drain is 60 amps. at 6.3 volts.

Complete details on this unit are available from the company.

MOBILE FM RECEIVER

Radio Apparatus Corporation, 310 Fountain Square Theatre Building, Indianapolis, Indiana, has developed a mobile FM receiver for the reception of all two-way FM telephone communications.

Known as the "Monitoradio," the new unit comes in two models. The M-51 is designed for the 30 to 50 mc. band while the M-101 covers the band from 152 to 162 mc. Both of these models are complete receivers. A specially designed whip antenna provides reception within a ten-mile range.

The units come in metal cabinets of gray hammertone. They each have

5 tubes plus a rectifier and a voltage regulator. The receivers are quiet under no-signal conditions.

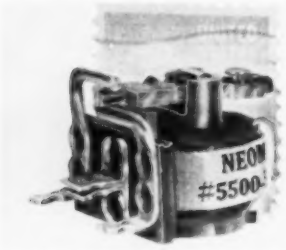
SUBMINIATURE RELAYS

A new series of subminiaturized, anti-vibration, Series M relays has been announced by *Neomatic, Inc.,* 879 Wellesley Ave., Los Angeles 49, California.

Developed to meet the exacting space requirements of manufacturers of radar and electronic components, the new relays measure less than $\frac{5}{8} \times \frac{3}{4} \times 2\frac{1}{16}$" and weigh less than ½ ounce.

The relays are built to withstand 20 g. vibration and more than 50 g. acceleration in any direction without affecting contact position. The coil is universal wound and vacuum impregnated for long life. The solder lugs are widely spaced for ease in wiring the units into the circuit. Mounting is

accomplished with a single #2-56 screw and an extruded locating pin to maintain alignment. Precision adjustment of the operating value is provided. For insulation of the armature from ground, the relay is available mounted on an insulated base. Screw-type terminals can be furnished on the same base if desired.



A variety of coil and contact arrangements is available. For complete details write the company direct.

"SUPER SNIFFER"

Nuclear Instrument and Chemical Corporation of 223 W. Erie Street, Chicago, Illinois, has announced the availability of a new and sensitive Geiger counter which has been tradenamed "Super Sniffer."

The instrument is an improved version of the company's "Sniffer" and features the addition of a flashing neon blinker light to indicate counts. The new unit is sensitive to both beta and gamma radiation and has a beta window to permit more careful checking of ores. Flashlight type battery loading simplifies this operation and a convenient belt clip on one side permits the instrument to be fastened to the carrier's belt. A radioactive source is supplied with the instrument for checking purposes.

A data sheet on the new "Super Sniffer" is available from the company on request.

10-METER MOBILE ANTENNA

Ward Products Corporation of Cleveland 3, Ohio, has developed a new transmitting antenna for 10-meter mobile applications that requires just a single $^{15}/_{16}$" mounting hole, thus eliminating the necessity of marring the finish of the car.

The Model SPP-143 is 55½" long, the shorter length removing many of the hazards and possibilities of damage inherent with the longer antennas when overhanging obstructions are encountered.

The new antenna is a modification of the company's SPPB71 unit which was designed for use as a detective car antenna. The rod assembly is designed to allow simple removal and replacement of the complete antenna rod in cases of non-repairable damage. Its ball and socket universal mount will fit any surface curving from between 35 degrees horizontal and horizontal. The female lead connection will accept commercial fittings for RG-8/U or RG-58/U coaxial cable.

NEW TIP JACKS

The *E. F. Johnson Co.*, Waseca, Minnesota, has designed a new tip jack which is said to offer longer life and better service.

In the new unit, contact is made along the entire length of the phone tip or test prod and remains unchanged despite insertion of an oversize tip, excessive binding forces, or long use.

These tip jacks are available in insulated style with molded Plaskon heads in ten colors. They are also available without the head for mounting directly in equipment, as well as in a variety of other types.

Manufacturers are invited to write the company for free samples and catalogue information.

CONDENSER KITS

Erie Resistor Corporation of Erie, Pa., is currently offering its line of "Ceramicons" to radio and television servicing companies in plastic service kits.

The new packages are covered and transparent, permitting the technician to see at a glance what the kit contains. Three kits are being offered at the present time; one containing "GP" Ceramicons for bypass and coupling applications, one containing disc and plate Ceramicons used in television receivers, and a third kit containing the company's "NPO" zero temperature-coefficient Ceramicons.

NEW OSCILLOSCOPE

Jackson Electrical Instrument Co. of 18 South Patterson Boulevard, Dayton 1, Ohio, is currently offering a full five-inch CR tube in its Model CRO-2 oscilloscope recently introduced to the trade.

The wide-band vertical amplifier response is uniform from 20 cycles to 4.5 mc. The unit features high sensitivity, .018 r.m.s. volt-per-inch. The vertical impedance is 1.5 megohms, shunted by 20 $\mu\mu$fd. The horizontal input impedance is 1.1 megohms.

THE HOME COLLECTION OF GREAT ART

Masterpieces

NUMBER 1 PRICE $1.00

5 MILLION DOLLARS IN ART TREASURES

175 OF THE WORLD'S MOST BEAUTIFUL PAINTINGS

26 FULL COLOR PLATES

PLUS:

Intimate biographical sketches of the great masters.

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Interesting, informative, text on how to understand . . . evaluate . . . judge art and discuss great paintings.

AT YOUR NEWSSTAND NOVEMBER 3rd

NOW . . . ONLY $1.00

MASTERPIECES is the greatest art publication value ever offered—anywhere. 175 of the world's most famous paintings—the best works of Raphael, Michelangelo, Titian, Rubens, Van Gogh, Picasso, Matisse, a hundred of the greatest Masters of all time—reproduced with every exquisite detail and glowing tone of the priceless originals.

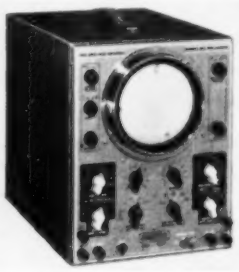
Order your copy of MASTERPIECES now. On sale at your favorite newsstand November 3rd or send $1.00 to

Masterpieces

185 N. Wabash Avenue • Chicago 1, Illinois

The voltage calibration permits peak-to-peak voltage measurement of all waveforms. The switching arrangement provides vertical pattern reversal. A new electronic return trace blanking system has also been incorporated.

The sweep oscillator provides sawtooth waves from 20 cycles to 50 kc.



in five steps. A sine wave sweep of 60 cycles is also available. The instrument has a removable calibration screen. A demodulation probe is available for use in signal tracing applications.

—30—

International Short-Wave

(*Continued from page 79*)

USA, OTM is still on 9.400 and *not* back on 9.380. (Stark, Texas, Bellington, N. Y., others) Still signs on 0000.

OTH, 9.21, Leopoldville, listed 15 kw., is coming in at 1200 in South Africa, usually in native program; OQ2C, *Radio College*, 4.98, usually is heard *only* 1130-1230 with musical broadcasts. (Hannaford)

Brazil—Current schedules being sent out by *Radio Jornal Do Commercio* are ZYK3, 9.565, 0455-1200, 1400-2100; ZYK2, 15.145, 0455-1400, and on 6.085, 1600-2100; *English* program "Brazil Calling" on 9.565 is weekdays 2005-2030, Sundays 1630-1700; QRA is Radio Jornal Do Commercio, Rua Marques do Recife, Recife, Pernambuco, Brazil. (Kroll, N. Y., others)

Radio Record, 9.605, Sao Paulo, is good to 2030 sign-off. (Richardson, D. C.) *Radio Nacional*, 11.72, Rio de Janeiro, noted 0410. (Bellington, N. Y.)

Radio a Voz do Oeste, Cuiaba, Mato Grosso capital, has just begun transmissions on 4.985 with 500 w. and call ZYZ5; m.w. outlet on 1160 kc. has call PRI3. *Emissora Continental*, Niteroi, State of Rio de Janeiro, will broadcast in the 60-m. band with 5 kw.; transmitter should be on the air this month or next. *Radio Difusora do Amazonas*, Manaus, still announces ZYS8 on 4.805; heard 1608 with identification, location, frequency, and QRA given in Portuguese, French, Spanish, *English*, Italian, German, and what sounds like Swedish; in each language, asks for reports to Rua Joaquim Sarmento No. 100, Manaus, State of Amazonas, Brazil. *Radio Cultura da Bahia* in Salvador, State of Bahia, will radiate on

1010 kc. and 3.445 in the tropical band; first transmission is planned for December. A *new* station is being set up in Curitiba, capital of Parana, to operate on m.w. and s.w.; the s.w. channel is being made possible by international agreement with Bolivia; station will be *Radio Campos Gerais;* more details promised soon. (Serrano, Brazil)

Bulgaria—Radio Sofia, 7.671, noted 1645-1700 with news; weak. (Cox, Delaware)

Canada—VED, 8.266, Edmonton, Alberta, usually gives this complete announcement every three hours—"This is VED, Edmonton, owned and operated by Northwest Territories and Yukon Trading System, Royal Corps of Signals." (Neeley, Oregon)

VE9AI, 9.54, also Edmonton, is strong signal in Oregon around 2115 but has bad QRM; news 2100; at present uses only 9.54 although still lists 6.005 as "night-time" channel. (Callarman)

CKFX, 6.080, Vancouver, British Columbia, heard with music 0145-0200, then news. (Cox, Delaware) CBRX, 6.160, also Vancouver, heard in Calif. around 1000. (Russell)

Cape Verde Island—CR4AA, 5.920, Praia, is good in Newfoundland 1530-1700 sign-off. (Peddle) Bellington, N. Y., who has heard this one on occasion, says the frequency is closer 5.895; clock chimes 1700, then off with "A Portuguesa."

Ceylon—Radio Ceylon, 15.12, is widely reported with good level throughout the U. S. now to 1205 closedown; BBC news relay 1100.

China—At the time this was written, *Radio Peking* still had news 0830 on 10.260, 15.054V; may be 0930 by now?

Sanderson, Australia, hears a Chinese station on 9.820 some days with news in Chinese 0700; old XGOE?

A Communist-Chinese outlet on 6.16 may be Shanghai; at times seems parallel with the outlet on 5.985, believed Shanghai, and which has had improved signal lately. (Balbi, Calif.) Balbi lists other outlets heard irregularly around 0800-0900 as 7.40 and 7.05.

Colombia—A *new* Bogota outlet on approximately 15.450 is heard to 2330 closedown; news in Spanish 2200 after three chimes. (Dary, Kansas) HJFB, 6.105, heard signing off 2230 with anthem, good level; HJDE, 6.145, noted leaving air 2330 with anthem, good signal. (Bellington, N. Y.) Stark, Texas, reports *La Voz del Norte* (Eso la Radio Cadena Nacional) at Cucuta on 4.870, *goes past* 2145; Stark comments that this country seems to be installing *many new transmitters.*

Costa Rica—TIPG, 9.615, San Jose, noted signing off 0000. (Russell, Calif.) TIFC, *"The Lighthouse of the Caribbean,"* 9.645, signs off in *English* 0006; excellent level; states reports should be addressed to P. O. Box 1307, San Jose, Costa Rica, and will be acknowledged with a souvenir. (Whitman, Ill.)

Cuba—COBZ, 9.026, Havana, noted with BBC's *English by Radio* at 1800. COCH, 9.437, Havana, heard signing off 0000 with *English* announcement; said would return 0600. (Cox, Delaware)

Cyprus—Sharq-al-Adna's 6.170 channel noted signing on 2255. (Bellington, N. Y.)

Czechoslovakia—Prague has settled down to North America at 1900 on 15.23, 2100 and 2230 on 11.84, 15.32. (Fargo, Ga., Fried, Mich., others) Noted on 9.55 at 2345 with recordings; audible to 0020 when Paris brings carrier on air. (Sutton, Ohio)

Dominican Republic—A station reported by Cox, Delaware, on approximately 3.290 is HI2L, *La Voz del Tropicos*, Trujillo (formerly on approximately 9.525); *goes past* 2200. (Stark, Texas)

Ecuador—HC2AM, 7.350V, Guayaquil, noted with music 0000-0100. (Sutton, Ohio)

El Salvador—YSBR, 4.795, *Radio Tropical*, Neuva Santa Anna, is heard in Texas to *after* 2100; strong signal. (Stark)

France—*English* from Paris is 1345-1445 on 6.145, 6.200. (Radio Sweden)

French West Africa—*Radio Dakar*, 11.896 and 15.341, still has *English* news 1400 (by woman) daily *except* Sunday. Noted by Whitman, Ill., signing on the 11.896 channel 0200, excellent level.

Germany—RIAS, Berlin, will begin transmissions on s.w. at the end of this year, probably on 42 meters. (Radio Sweden)

Greece—"The Greek Armed Forces Radio Station" in Athens is under the supervision of the Greek General Staff. Broadcasts daily on 6.340 at 2330-0200, 0500-0800, 1100-1630; power is 200 w., soon to be increased to 1 kw. So far, reports have been received from Sweden, England, Venezuela, Australia; station officials state than an *English* program will be added soon for overseas listeners; this one is heard by Pearce, England, at 1345-1627 sign-off.

The Greek Army station at Kavala, 7.650, is now on the air until 1600; some sources say has changed frequency to 7.590. (Radio Sweden) Pearce, England, believes this one is now on 7.600; Kavala verified earlier report for him from Rokkos Toulios, Station Engineer, Radiofonicos Stathmos Enaplon Dimamen Anatol Makedonias S. Thakis, Kavala, Greece.

Guatemala — TGWB, 6.43, noted leaving the air 0005 with female chorus singing anthem; fair level in New York. (Bellington)

Haiti—4VRW, Port-au-Prince, more recently has been on 9.835 although still announces 10.135. Now signs off around 2200, sometimes with *English* announcement; asks for advertising to be given in French, Spanish, or *English*. (Leary, Indiana; Stark, Texas)

Holland—PCJ, Hilversum, has a *new* QSL card. (Herd, Delaware)

Honduras — HRN, approximately 5.975, noted with popular music 1942.

(Cox, Delaware) Heard to 2330 sign-off. (Sutton, Ohio)

Hong Kong—ZBW3, 9.525, noted 0700 with BBC relay, weather report, warnings to ships. (Sanderson, Australia)

Hungary—At the time this was written, *Radio Budapest*, 11.910 and "claimed" 9.820 (actually around 9.8345) was being heard to Britain and Europe with news 1600 and 1815; and in *new* transmissions to North America (in *English* and Hungarian) around 1930-2030, 2300-2400. (Bellington, N. Y., Fargo, Ga., others) The 31-m. outlet is good on West Coast 2330-2400 while the 25-m. channel has some QRM. (Balbi, Calif.)

India—A "wavelength" schedule just in via airmail from AIR, Delhi, lists *English* periods as—2130 (news), 17.76, 11.83, 9.68, 9.565, 7.275, 7.225; 2315, 17.79, 15.16; 0230, 21.700 (*presumably a new outlet*), 17.78; 0300 (news), 17.76, 15.29, 11.83; 0530 (Sat., Sun. *only*), 17.76, 15.16; 0730 (news), 17.76, 15.29, 11.83, 9.68; 0830, 17.84, 15.35; 1030 (news), 15.16, 11.83, 9.68, 9.59, 7.225, 6.01; 1045, 15.13, 11.79; 1400, 11.76, 9.62, and 1930, 17.83, 15.16.

Indo-China—The 6.19 outlet has been heard announcing as *Radio Dalat*; French news 0745; "Voice of Vietnam," 9.62 and 7.265, has news 0900 lately. Recently, an outlet on 6.115 has been heard in parallel with Saigon's 6.165 channel 0730-0830; powerful signal; the 11.83 outlet remains weak. (Balbi, Calif.)

Iran—Radio Teheran, 15.100, is still sending a good signal to Eastern U. S. 1500 with news. (Fargo, Ga., others) Heard in parallel on 9.660 occasionally but is much weaker than the 15.100 frequency. (Cox, Delaware) Teheran verified reception of the Regional Unit on 4.040 (*now on* 3.960) and gave call as EPP; power not stated. (Cushen, N. Z.)

Israel—Tel Aviv is back on approximately 9.018 (announced 9.000) with news daily 1600 in broadcast of the World Zionist Movement from Jerusalem; tested on various channels but informed Pearce, England, that has settled down on 9.000 which seemed to give best results for listeners in the 31 countries from which reports on tests were received; at times has bad QRN and CWQRM here in Eastern U. S.

Tel Aviv's 6.83 outlet was noted recently opening 2230, poor level in N. Y. (Bellington)

Jamaica—Radio Jamaica, 4.950, operates weekdays 1600-2300, Sundays from 0800, according to verification. (Radio Sweden) May still use 3.480 at times. The 4.950 channel is being picked up in Sweden around 2000, according to Ohrwall.

Japan—JKL, 4.860, Tokyo, noted 0800 with AFRS news; good signal in Oregon. (Neeley) JKL2, 9.605, noted 0415 with variety program. (Sanderson, Australia) JKJ, 7.285, noted with 15-minute program in *English* (probably *English* lesson) at 0300, fair level in Calif. (Stein)

Kenya Colony—Nairobi, 4.855, usually is heard well in the United Kingdom at 1300 with BBC news relay, 1315 with local news and weather forecast for Kenya and Uganda. (ISWC, London)

Korea—Radio Pyongyang was back on its old channel of 4.40 at the time this was compiled; strong signal noted around 0730-0930, but no *English* heard; Seoul, 7.933, not heard lately. (Balbi, Calif.) Seoul has been heard on 2.510, however. (Dilg, Calif.) Believed in dual with Pyongyang now. Cushen, N. Z., airmails me that he has heard Pyongyang, 4.400, at 0700 with prisoner-of-war messages in *English*, and that Seoul, 7.933, has been heard in *English* at 0900.

Lebanon—Beirut, 8.036, sent QSL by registered airmail and gave schedule of 0000-0130, 0530-0730, 1000-1600, *English* at 1000-1100. (*Short Wave News*, London)

Luxembourg—Radio Luxembourg is currently using 15.35 at 0600-0830; 6.090 at 1300-1830. (Radio Sweden)

Madagascar—The French-speaking station signing on around 2230 on approximately 9.515 is believed to be *Radio Tananarive*. (Parker, N. C.; Stark, Texas; Bellington, N. Y.)

Malaya—Kuala Lumpur, 6.025, noted 0600 with musical request session. (Sanderson, Australia) Should have news 0630, followed by stock exchange report.

Malta—FBS, Middle East, 7.220, noted from 2300 in parallel with 4.965. (Cox, Delaware) The 7.220 channel signs off 0115 after a short religious service; also noted leaving the air 1600 with Ted Lewis' "Goodnight Song." (Bellington, N. Y.) Noted in England 0700 on 7.220 and 11.895. (Pearce)

Mauritius—In the daily 2200-2315 session, Forest Side, 15.050V, has BBC news at various times—such as 2200, or 2230, or 2300. (Cox, Delaware)

Mozambique — CR7BJ, Lourenco Marques, noted back on approximately 9.81 for Portuguese session 0000-0100. (Balbi, Calif.)

The outlet on about 4.925 noted in South Africa 1500-1530 in *English;* woman announcer identified at 1600 and the station left the air after playing "A Portuguesa." (Hannaford) Also noted by Pearce, England.

New Zealand—Cushen, N. Z., lists *Radio New Zealand* currently at 1300-1545, ZL8, 9.62, ZL3, 11.78; 1600-0145, ZL4, 15.28, ZL10, 15.22; 0200-0530, ZL3, 11.78, ZL8, 9.620; notes that sign-off is now 0530 (*except* Saturday when station operates until 0630) due to power restrictions.

Northern Rhodesia—Lusaka, 3.914, 7.220, is heard 0930-1230 with programs in native and *English*. (*ISWC*, London)

Norway—Radio Sweden and other sources report that the Oslo students' station has been operating irregularly this autumn around 1700-1730 or later on 7.24 and 11.85. Heard in England by Pearce on 7.24 around 1705.

(*Continued on page* 181)

Record Reproduction

(*Continued from page* 41)

bles. A heavy construction for the arm with large masses used for counter balancing means that there will be a high initial resistance to an upward movement caused by warpage of the record. Under these conditions the stylus will dig into the groove and damage the walls, and the stylus will itself be worn down rapidly. If these motions are abrupt the arm may tend to hang slightly after it has been thrust upward and will not immediately follow the downward slope, losing contact with the grooves and causing serious distortion. This indicates strongly the desirability of using arrangements of spring counterbalancing with structures of low mass in the arm. On the other hand, the arm must not be too light or the stylus will vibrate the arm as it passes through the modulation in the grooves instead of moving with respect to the cartridge suspensions and thereby generating a signal. There is one other way to solve the latter problem. The mass required to allow the stylus to move freely without appreciable effect on the arm is related to the compliance of the stylus support. If these suspensions are suitably designed, it is possible to make the mass of the cartridge alone adequate to provide optimum operation, and the mass of the arm becomes unimportant. This is true of some very high quality cartridges.

In order to maintain reasonably high lateral mass and still keep the vertical mass low, it is possible effectively to decouple these two structures by using an arm that is vertically rigid for a large portion of the distance from the lateral pivot to the cartridge and placing the vertical bearings relatively close to the cartridge. One of the problems in this design is involved with the fact that the closer the vertical pivots are to the cartridge, the sharper will be the arc in any upward motion. A tight vertical arc includes an appreciable component of motion against, or with, the direction of groove travel. In other words, if a sharp rise in the record surface causes the stylus to move upward, a tight arc will mean that it simultaneously moves backward, and when it comes back down it moves forward slightly. If the vertical pivots are too close to the cartridge, as they have been in some designs, this will produce frequency modulation of the signal and associated distortion.

Most record changers are designed with velocity trip mechanisms. The reason for this is that the changer mechanism will be triggered by eccentric run-in grooves, and compensation for differences in the inside diameter of the recorded surface is not necessary. Although this system has definite advantages of convenience and versatility, it has the disad-

vantage of requiring in most designs that the stylus, cartridge and arm structures operate against a spring tension as they move inwards. This loads (biases) the stylus against the outside wall of the grooves and tends to produce differential wear as well as other undesirable effects.

In the *Lincoln* changer, mentioned previously, the trip mechanism functions entirely in terms of the diameter. In other words, when the stylus gets to a specific inside diameter on the record the changer mechanism is tripped and the eccentricity of the inside groove has nothing to do with it. The undesirable feature of this involves the fact that there is an appreciable difference between, for example, most 78 r.p.m. and most long playing records with regard to the inside diameter of the recorded portion of the surface. This means that it is necessary to adjust the preset tripping mechanism when changing from standards to microgrooves. In order to make it possible to adjust this for various in-between conditions, the control should be (and in this case is) continuously variable.

All of the considerations discussed involve the stylus, the pickup cartridge and the arm, and this is only an outline of the beginning of the chain of components in a music reproducing system. In common with many other technical subjects the problems of music reproducing systems seem at first complicated; then a block diagram of a record changer, amplifier, and loudspeaker makes them seem comparatively simple. Finally when a little knowledge brings realization of all the detailed problems, the engineer and the audio enthusiast seeking perfection recognize that there is no end to learning about this subject. That, of course, is why audio engineering is such an absorbing hobby or profession.

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RCA's super-gain antenna atop the National Lottery Building, Mexico City, radiates the signals of Mexico's first TV station, XHTV. All equipment for this new station was supplied by Radio Corporation of America.

Equalizing Preamp

(*Continued from page 49*)

able for introducing the output of either a phono preamplifier or an AM or FM tuner.

One peculiarity of the circuit is that the volume cannot be reduced to zero. This is caused by the resistor in series with the lower end of the volume control. The gain can be reduced, however, to a lower value than would be used for listening.

As in any amplifier which does not have the volume control located in the first tube's grid, overloading of the first stage is possible. Care must be exercised when connecting this unit to a tuner, for instance, so that the output of the tuner does not provide too great a signal voltage for the 6J7 input tube.

The easiest way to avoid such trouble is to advance this unit's volume control to maximum; then connect the tuner. Advance the tuner's volume control until the speaker volume is as loud as you will ever need. The unit will not overload under these conditions, and the volume can now be varied by means of the volume control, or if it has several audio stages, a potentiometer may be connected between the tuner and this unit temporarily. This control may be adjusted as desired and then replaced with two resistors. The value of the resistors will be the same as the resistance values measured with an ohmmeter between the temporary volume control's movable arm and each end.

As these resistors are used in a low level position, they should be placed with care to eliminate the possibility of hum pickup.

The unit should be adjusted at the level which the listener uses most. The variable tone controls may be set for the most natural sounding reproduction.

If the constructor desires to set up the unit in a scientific manner, the volume control should be set to the full position and an audio oscillator connected to the unit's input. The audio oscillator output should be adjusted at 1000 c.p.s. for a level of approximately 100 db. which is about half of full volume from a 10 watt amplifier into an average 15" speaker. The oscillator should be then varied from 30 to 15,000 c.p.s. All of the frequencies in this range should be heard at the same level. The two equalizer controls should be set so this condition exists. Then the volume control may be changed to a lower level, and it will be found that the entire frequency range is still audible at the same level.

Since loudspeakers have great difficulty in reproducing low frequencies at successively higher levels, due to restricted cone travel and inadequate coupling to the air, this unit acts to reduce low frequency distortion due to overload of the loudspeaker on low frequencies as the volume control is advanced. This unit, then, provides one more device which relieves the listener of mechanical manipulation so that he may be free to enjoy the program material he has selected.

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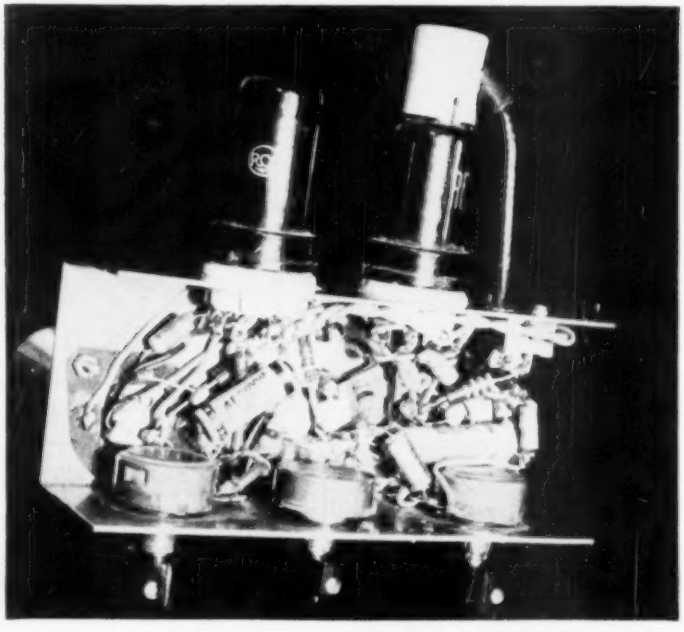
Under chassis view. Note the tubes mounted on the rear flange of the preamp unit.



NEW EQUIPMENT FOR THE AUDIO ENTHUSIAST

TAPE RECORDER

A new and portable "Re-Cord-O-fone" tape recorder, the Model RT-65, has been announced by *Bell Sound Systems, Inc.* of 555 Marion Road, Columbus 7, Ohio.

Particularly adapted for home, professional, and business users because

of its compactness and light weight, the new unit measures only 8½" high, 15" wide, and 16" deep. It weighs 33 pounds.

The unit records for immediate playback and is simple to operate. Through direct connection to radio, phono, or microphone, this equipment records any type of sound on plastic or paper tape, using 5" or 7" reels. Half of the double-track tape can be recorded or erased at a time. The 5" reel provides 30 minutes of recording time while the 7" reel provides an hour's coverage. The tape is reusable. The unit automatically erases as it records, eliminating the possibility of double recordings. An interlock switch prevents accidental erasure when the tape is being rewound.

The Model RT-65 comes complete with a crystal microphone, a 6 foot cable, an empty 5" reel, one 5" reel of plastic tape, and an instruction manual. Those desiring full details on this recorder should address their inquiries to H. H. Seay, sales manager, in care of the company in Columbus.

ELECTRIC PHONODRIVES

A new line of electric phonodrives has been introduced to the trade by *Russell Electric Co.*, motor division of *Raytheon Manufacturing Co.*, 4501 So. Western Blvd., Chicago 9, Ill.

Featuring the company's "Cat's-Paw" tangent-contact drive, the new line consists of three models comprising a three speed unit (Model DTP) which operates at 78, 45, or 33⅓ r.p.m., and two units, the Model DSP (deluxe) and the Model FSP (economy) at 78 r.p.m.

The model DTP has a rim-drive, 2-pole dynamically balanced motor and features a positive turret drive mechanism with a shift lever control throwing the drive wheel into instant positive contact with the motor shaft for the desired speed. The model is provided with either a 7¾" or 9" diameter turntable. An adapter disc for 45 r.p.m. records and a speed indicator plate is also included.

A copy of Bulletin No. 5000, covering these new phonodrives, will be mailed on request.

POLYPHASE REPRODUCER

Audak Company of 500 Fifth Avenue, New York 18, New York, is currently marketing a new polyphase reproducer, the "Audax L-6".

This single magnetic unit will play any and all lateral recordings at speeds of 33⅓, 45, or 78 r.p.m. A special connector is available which permits the unit to be plugged into the *Webster* changer arm and once the unit has been plugged in it becomes a permanent part of the arm, thus eliminating repeated adjustments on the arm.

The point pressure is 8 grams for all discs. The output is approximate-

ly 20 mv. Response is from 20 to over 10,000 c.p.s. The sapphire or diamond stylus is easily replaceable.

Full details on the L-6 are available from the company.

L-PAD

A new L-Pad for special application work where dependability and cost are important factors has been introduced by *Clarostat Mfg. Co., Inc.* of Dover, New Hampshire.

Known as the Type No. CM8727, the 8 ohm pad is a single unit with two separate wire windings for maintaining constant impedance. The unit was designed primarily for outdoor drive-in theaters and other p.a. uses.

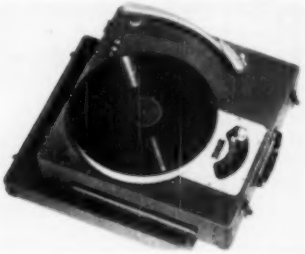
The unit measures 1⅛" in diameter and 9/16" deep. It is available on special order with impedance ranges from 6 to 300 ohms. Rotation of the control is 120 degrees.

VARIABLE SPEED TURNTABLE

Rek-O-Kut Company, Inc. of 38-01 Queens Blvd., Long Island City, New York, has announced the production of a continuously variable speed turntable featuring the company's exclu-

sive "Vari-Con" self-seating rim drive.

The new turntable plays without wow at any speed from 20 to 100 r.p.m. at 50 or 60 cycles a.c, according to the



company. The company suggests that the new unit may be used by disc jockeys, TV-AM-FM broadcasting stations, advertising agencies, schools, dance studios, record collectors, and musicians.

The speeds are regulated by a simple lever movement. The unit has a 12" cast aluminum turntable with hardened and ground shaft and a constant speed, 4-pole motor with cone pulley.

SMALL INTERCOM

An inexpensive yet complete two-station intercom system is currently being offered by *Mark Simpson Mfg. Co., Inc.*, 32-28 49th Street, Long Island City, New York, as the "Masco Midgetalk."

Consisting of one master station with "on-off" switch, volume control, and "on-off" pilot light; 50 feet of 3-wire cable; and one remote station, the new intercom can be installed rapidly and easily. The remote station can be wired for either private or non-private operation. Both stations have a press-to-talk switch and when the remote station is wired for privacy, the switch is used to originate a call to the master.

The standard model comes in a mahogany finish but decorator colors

are available at slightly higher prices. A catalogue sheet covering the new intercoms is available on request.

TWO-WAY SPEAKER

Holl Audio Industries of 9215 Venice Blvd., Los Angeles 34, California, has added the new 802-A two-way loudspeaker to its line.

Air column loading is used in this new speaker. When placed in the corner of a room, the cabinet acts as the neck of a horn while the room walls and floor form the mouth.

The 15" woofer with a 2 pound Alnico V magnet and a 2" voice coil is

placed at the top of the cabinet while the port is at the bottom. The cabinet is 50" high, 28" wide, and 16" deep. Corner reflectors at 45 degree angles are used at both the top and bottom of the cabinet to direct incoming and outgoing sound waves.

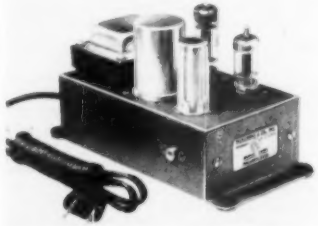
The crossover is at 800 cycles, 12 db. per octave. Power rating is 20 watts, 16 ohms. The network uses air core coils and construction meets theater standards.

A brochure covering this new speaker is available on request.

PICKERING PREAMP

The Model 230H, a new, compact, small-size preamplifier to equalize low frequencies and provide necessary gain for magnetic pickups, has been announced by *Pickering & Company* of Oceanside, Long Island, New York.

The new preamp is self-powered, operates with any high-quality, high-input impedance amplifier and is installed by plugging it in. The company claims that the new unit is superior



to most broadcast station equipment in its frequency response and accuracy of equalization, and that its intermodulation and harmonic distortion are exceptionally low.

BRITISH SPEAKER

A new British-made speaker, the Wharfedale W10/CSB, is now being distributed in the United States by *Sun Radio & Electronics Co.*, 122-124 Duane Street, New York, New York.

This speaker is a 10" unit especially designed for medium-sized and small rooms. Response is said to be comparable to most 12" to 15" speakers, without the booming effect caused by the larger speakers when used in small rooms.

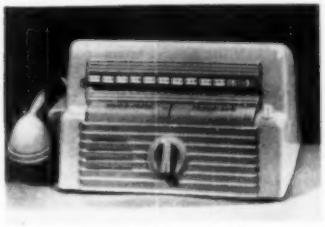
The center diaphragm reacts to highs, while the larger paper cone handles the lows. The cone is suspended by cloth in order to eliminate carryovers. Power input is 5 watts and the impedance is 12/15 ohms. A special cabinet has been designed to house the new speaker and full details on both the speaker and the cabinet are available from *Sun Radio*.

"REDI-POWER"

Designed to overcome high noise levels and solve unusual intercom problems, the *Talk-A-Phone Co.* of 1512 S. Pulaski Road, Chicago, Illinois, has introduced a new self-compensating control unit.

Named "Redi-Power," the new unit

provides power to reply from considerable distances. It automatically supplies exactly the right amount of power at any time for any station in an intercom system, and is especially effective in factories, schools, or large



industrial establishments where there is a high noise level or where remote installations complicate intercommunication.

The new feature is built into the company's stylized bakelite cabinet which is finished in either walnut or executive gray. A brightly colored push-button alongside of the touch-bar and station control buttons makes the operation of "Redi-Power" instantaneous and convenient.

SMALL RECORD PLAYER

In order to meet the demand for a small record player, *Audio-Master Co.* of 23 West 45th Street, New York 19, New York, has recently introduced the "Audio-Master, Jr."

The new player is a three-speed portable electric phonograph which will handle 33⅓, 45, and 78 r.p.m. records up to 12" in size. It has a high gain amplifier and a 5" permanent magnet speaker with a 1.47 ounce Alnico V magnet.

The unit also features a variable volume and tone control, and a lightweight tone arm which employs a

semi-permanent long-life needle that plays all speeds. The player is housed in a compact case which is available in various shades of colorful fabricoid.

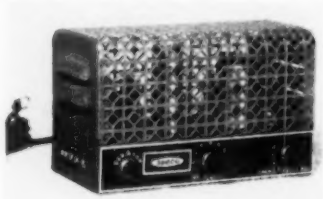
SPECO AMPLIFIER

Special Products Company of Silver Spring, Maryland, has recently introduced the *Speco* Model 313 phono microphone amplifier as its answer to the demand for a reasonably priced, all-purpose, high-fidelity amplifier unit.

This small, lightweight, shockproof unit measures only 8½" by 5⅜" by 5" and weighs just 4 pounds. The response is substantially flat from 40 to

15,000 c.p.s. within ± 2 db. The power output is 3 watts and the unit uses four tubes.

As a result of using a specially designed output transformer within the feedback loop, the generator resistance of the output stage is kept to a fraction of the load impedance thus allowing the connection of any speaker voice coil of from 3 to 16 ohms without loss of power.



A data sheet covering the new Model 313 is available on request.

RECORDING TAPES

Duotone Company of Keyport, New Jersey, is currently in production on a complete line of magnetic recording tapes.

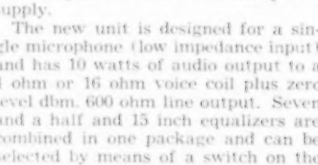
The new line includes both plastic and kraft paper base tapes in extra-long 625 and 1250 foot lengths. The tapes are supplied with a low inertia plastic wheel which is said to be warp and shatterproof. The new type tapes are interchangeable with other good quality tapes making it possible to splice tapes while retaining consistently fine quality reproduction throughout the playing of recordings.

The company will supply complete details on these new tapes to those requesting this information.

AMPLIFIER UNIT

Magnecord Inc. of 225 West Ohio Street, Chicago 10, Illinois, has developed a new amplifier which is, in reality, separate recording and playback amplifiers with a common power supply.

The new unit is designed for a single microphone (low impedance input) and has 10 watts of audio output to a 4 ohm or 16 ohm voice coil plus zero level dbm. 600 ohm line output. Seven and a half and 15 inch equalizers are combined in one package and can be selected by means of a switch on the front panel. The vu. meter reads bias,



recording level, or playback level as selected by a front panel switch.

This amplifier is designed to be used with a three-headed (PT63-A or PT63-AH) recorder mechanism when the latter is purchased originally equipped with the three heads.

NEW AMPLIFIERS

Altec Lansing Corporation, 9356 Santa Monica Boulevard, Beverly Hills, California, has announced the availability of six new amplifiers which comprise the 1400 series.

Included in the new line are the 1410A preamplifier, a 35 watt A-1402A power amplifier, a 75 watt A-1430A power amplifier, the A-1440A line amplifier, the 1450A apparatus unit, and the 30A power supply.

The new units can be used in various combinations to provide complete flexibility of application. Full details, including specifications, can be secured either from the company direct or from the *Graybar Electric Co.* outlets which are handling the distribution of the 1400 series.

NEW DYNAMIC MIKE

American Microphone Company of Pasadena, California is currently manufacturing a new full-vision, dynamic microphone which has been designated the D-33.

Designed to meet the need for an inconspicuous microphone for stage, screen, radio and television work, the new unit is finished in gold and black and has omnidirectional pickup. No

preamplifier is required with this mike. The D-33 is easily mounted for stand or suspension use and may be quickly detached for hand use. It weighs only 7 ounces and is available in all popular impedances. It comes equipped with a *Cannon* "Latch Lock" plug and 25 feet of two-conductor shielded cable.

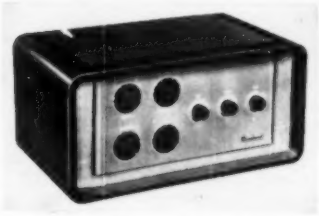
32-WATT AMPLIFIER

The second of the company's "Green Gem" p.a. amplifier series has recently been released by *Rauland-Borg Corporation* of 3523 Addison St., Chicago 18, Illinois.

The new Model 1932 is rated at 32 watts at 5% or less harmonic distortion (measured at 100, 400, and 5000 cycles) with 48 watts peak output. The amplifier features 3 microphone inputs, 2 phono inputs with dual fader, electronic mixing and fading on all 5 inputs, and separate bass and treble

tone controls. Frequency response is plus or minus 1 db. from 40 to 20,000 c.p.s. Output impedances are 4, 8, 16, 166, 250, and 500 ohms.

The unit is housed in dark-green hammerloid case with the control



panel, finished in metallic bronze, set in a perforated aluminum-finish front section. A bulletin covering the Model 1932 amplifier is available on request.

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Sound System Selection
(*Continued from page* 81)

specifications. Record wear and mechanical operating features are also prime considerations in the selection of a good phonograph. Improper pick-up arm balance and faulty record changing mechanisms can produce marked wear and tear on good recordings. At slow speeds, the failure of the phonograph to operate uniformly will result in "flutters" and "wows" which will destroy any semblance of high-fidelity reproduction. The record player must be silent and dependable. Once again, you will be wise to purchase the best phonograph available which will meet the requirements of your system at the price you can afford.

Amplifier

The selection of an amplifier for your high-fidelity system must be correlated with the selection of the FM-AM tuner and phonograph. The frequency response must be adequate to uniformly and faithfully reproduce the signal from the tuner and phonograph applied at the input. In general, the output of the tuner will be the determining factor in frequency response since it is usually of higher caliber than that which can be obtained from even the best of phonographs. In addition, the type of tuner which you purchase will determine whether or not bass and treble tone controls are necessary on the amplifier. If these controls are available on the tuner, it is usually unnecessary to duplicate them on the amplifier.

The type of phonograph pickup which you choose will determine whether or not a preamplifier for magnetic cartridges is necessary. However, as a rule, the better amplifiers include this item within the main unit. If the one which you select does not contain a preamplifier, the additional cost of such an item must be considered a part of the over-all amplifier price.

The output requirements of the amplifier will depend upon the size of room into which the sound will be delivered and the type of speaker selected to do the job. It should be remembered that it is always better to have more power available than is necessary since most amplifiers operate to their best advantage at something less than full-rated output. The volume control always permits you to reduce the available output at will. Hum and distortion levels in your amplifier must be kept below the audible level for faithful reproduction.

For comparison purposes the following are the specifications for one of the best available amplifiers: Frequency response—20 to 20,000 cycles ± 1 db.; hum and noise level—70 db. below normal-rated output; over-all distortion—2%.

Speaker

The problems involved in the selection of a good speaker for your high-fidelity system are dependent to a certain extent upon the individual making the selection. It is only natural that since the speaker is actually what you hear, part of the selection will be made on the basis of the degree to which the speaker pleases you as the listener. However, certain basic fundamentals must be considered. First and foremost, the speaker must be capable of handling the power output of the amplifier to which it is connected without distortion or strain. Its electrical characteristics (frequency response, distortion factor, and impedance) must match those of the amplifier if the over-all performance of the system is to be maintained.

Some engineers insist on two separate speakers—one to reproduce the high frequencies (the "tweeter") and one to reproduce the low and middle range (the "woofer"). If the two speakers are mounted on the same axis, the resultant unit is known as a coaxial speaker. Such a mounting arrangement conserves space.

The physical characteristics of your sound room play an important part in speaker selection. Size and shape can often prove to be the deciding factors.

Speaker Housing

The fifth item in your high-fidelity system, the speaker cabinet, must be considered along with the speaker itself since the two are interdependent. Proper housing of the speaker away from the other components contributes a great deal to the over-all quality of the entire system. All too often the speaker is mounted on a baffle of improper size or in a cabinet of improper dimensions. This results in distortion and poor sound distribution within the room itself. Highly desirable "wide-angle distribution" in a good speaker can be destroyed because of improper housing. With the selection of a speaker and suitable speaker housing, you have completed your choice of components for your high-fidelity system.

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shunt capacitance to keep readings within about 1 db. up to the topmost frequency of the oscillator. Unbypassed cathodes and the use of miniature tubes help. Rectifying the signal before applying it to the 6E5 is the usual thing, but it did not seem to be necessary here as the edge of the shadow is entirely sharp enough for easy reading.

The power supply is conventional, with choke input for good regulation. A pair of 0C3's provides a regulated 210 volts to help stabilize the two oscillators and the mixer. The 6E5 is powered with just 105 volts to make it more sensitive. It requires only 1.2 a.c. grid volts (r.m.s) for zero shadow angle.

Construction

Most of the cabinets sold for purposes like this are too deep for their height compared to the cases in which commercial instruments come, and the hinged door on top does not allow attachment of a carrying handle. To make for easy handling, a *Bud* so-called utility box, with dimensions 12 inches wide, 11 inches high, and 8 inches deep, was chosen for the oscillator. The front and rear panels are removable. A 7 x 10 inch chassis, 2 inches high was the largest that would fit into the cabinet. While it is a shade small for the number of components in the instrument, careful wiring and parts placement (see under-chassis photo) made it a success.

The top-chassis photo shows the parts layout. Looking down on the chassis from the rear and starting at the right of the photo, V_1 is first, followed by V_2, V_3, V_4, and V_5. The power transformer is at left and the two chokes at right, with the rectifier and filter condenser between the two. The two voltage regulators are in front of the chokes.

The two cans making up C_{28} are mounted on a piece of aluminum fastened to the front panel and the v.t.v.m. tubes V_7 and V_8 are on a similar aluminum piece on the opposite side.

The front-panel photo shows all the controls. At bottom (left to right) are the zero beat control (R_3), power switch (S_1), "Use-Calibrate" switch (S_2), output control (R_{29}), and impedance switch (S_3). The three output terminals are at right, the v.t.v.m. input terminals at left. Just above the latter are the v.t.v.m. preset control (R_{20}) and the calibrated potentiometer (R_{21}). The main frequency control occupies most of the front panel.

This layout is given in fair detail only as a suggestion for other constructors, since many other layouts will do as well. Certain points are important, however, such as having some separation between the two oscillator

tubes and keeping the three a.f. amplifier tubes fairly close together. There is apparently no harm in having the power supply components so close to everything else; there is no hum in the output, probably because leads were kept short and there are no inductors in any of the circuits that matter. Another point is that only a single connection to the chassis was made, all other ground points being connected together by *Wirex* to avoid hum loops.

No shielding whatsoever is necessary for the oscillators but all leads should be kept short. Terminal-board construction would have looked better but probably would not work as well, at least on the first try.

The gain of the v.t.v.m. amplifiers is about 45 db. and they are somewhat microphonic. That is harmless but the subassembly must be kept compact to avoid loss of high frequencies. All parts were mounted on the aluminum subchassis with very short leads before it was fastened to the panel.

This type of cabinet has a ½-inch lip around each of the four front and back edges. When fastening the chassis to the panel and mounting controls, therefore, spacing washers are necessary between chassis and panel so that there is room for the lip between them.

Calibration

The main tuning dial is made from a *National* ACN unit and an 8-inch recording blank. The ACN drive unit is fastened to the front panel in the usual way but the rectangular frame, calibration paper, and plastic pointer were discarded. To avoid backlash, a *Millen* 10012 right-angle drive is used to turn the main tuning potentiometer (R_{2b}) which is mounted on the chassis deck to avoid long leads from the variable oscillator. There is a little looseness in the drive which can be reduced by loosening the setscrews holding the gear shafts and pushing the gears together more tightly.

The large dial spreads out the calibrations very satisfactorily. An 8-inch aluminum-base recording blank was soaked in hot water and the lacquer peeled off. Then the center hole was enlarged slightly to allow it to fit over the ACN dial shaft and three 120-degree-spaced holes were drilled for attachment to the dial mechanism. The plastic pointer that comes with the ACN was cut and drilled, then fastened to the top of the panel.

Before calibration, the instrument should be lined up and tested. If there is any trouble with the oscillators, they may be connected to an oscilloscope for observation. Both should have good waveform when their frequencies are equal, as they should be when R_{2b} is at maximum resistance. Some slight trimming of oscillator component values may be necessary to get them equal to R_3 in about the middle of its range. R_{2b} should be set so that with oscillator

and mixer tubes removed current through the OC3's is about 30 ma.

For the frequency calibration, a paper disc about 5½ inches in diameter was fastened over the center of the 8-inch aluminum disc and the assembly was fastened in place. Starting at maximum counterclockwise rotation of R_{2b} with R_3 set for an audio frequency of about 200 cycles, a slow rotation clockwise showed that there was a slight discontinuity in frequency change about 30 degrees from maximum resistance. At the point of the discontinuity, which is the point of real maximum resistance for R_{2b}, the paper on the dial was marked zero frequency and R_3 was adjusted for zero output as indicated by the oscilloscope and a meter.

Rotation of R_{2b} toward minimum resistance was then continued, marking calibrations on the paper at each desired frequency. Another oscillator was compared with the new one at each point by using the oscilloscope's Lissajous patterns in the usual way. Operation of the 6E5 as a zero beat indicator was checked (with S_1 in the "Use" position); the shadow varies at some multiples of 60 cycles and at zero frequency but the character of the shadow action at 60 cycles is readily distinguishable.

The aluminum dial was removed and the outer edge area coated with rubber cement, which was allowed to dry and then rubbed off with the fingers. With the paper disc as a guide, black India ink, with a regular drafting compass and a *Speedball* FB6 pen, was used to draw in the calibration marks. The numbering and lettering was done with a *Wrico* lettering guide and pen. Drawing right on aluminum requires great care and some practice, for mistakes cannot be erased. It is entirely practical, however, if the aluminum is mirror-smooth and is first cleaned as indicated with rubber cement. The paper disc is removed easily afterward. When lettering was finished and checked, a transparent coating of "New-Skin" (obtainable at drug stores) was brushed on. This is nearly the same thing as colorless nail polish but is cheaper. Do not brush more than twice over one spot as the compound will dissolve India ink. Brush marks will not show. A second coat after the first one dried completed the job.

Exactly the same process was used to mark the small dials. *ICA* 2165 dials were purchased and the metal skirts reversed to obtain a blank surface. The small white marker lozenge on the panel above each dial was a decal obtained from a *Tekni-Cal* set. The lettered designations are the same.

To calibrate the v.t.v.m. dial, feed in a tone directly from the oscillator terminals. Set R_{2b} at maximum and R_{2a} for exactly zero 6E5 shadow angle. Do not touch R_{2a} again during the calibration.

Place an external vacuum-tube voltmeter across the oscillator output and

note the voltage. Using a decibel table, increase the signal 1 db. at a time as shown on the external v.t.v.m., each time making a mark on the paper disc attached to the dial of R_x after readjusting it for exactly zero shadow angle on the 6E5. The total useful range with a standard potentiometer is about 16 db.

Divide this into plus and minus, so that calibration runs from about plus 8 to minus 8 db. (with minus in the direction of clockwise rotation). Now when using the voltmeter, the calibrated control is set at zero decibels and the "Preset" is adjusted for exact shadow closure at reference level—usually at 1000 cycles. As the output of the tested device varies with frequency the calibrated control is reset for shadow closure and the increase or decrease in signal transfer read from the dial in decibels.

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Mac's Service Shop

(Continued from page 82)

"Not so well as we are going to do," Mac promised. "I have signed up for some newspaper advertising and have taken a spot announcement on the local radio station explaining that we are ready and eager to take care of any and all p.a. requirements. Our office force, Miss Perkins, has been alerted to comb the newspapers for any news of picnics, reunions, bazaars, etc., at which a public address system might be needed. When she finds a promising lead, she immediately contacts the chairman of the committee on arrangements and gives him or her a powerful sales talk on our service.

"To take care of all the business that these methods will bring in—I hope—several new pieces of p.a. equipment have been ordered. I intend to have enough of everything on hand so that one complete sound system will always be in reserve here at the shop. No servicing of our equipment will be attempted in the field. If trouble develops, we shall simply determine what portion of the system is at fault, yank that unit, and slide in a replacement. That means our customers will get the fastest possible service, and it also means that an untrained technician—even you—can take care of a complaint."

"Ignoring your snide insinuation," Barney loftily answered, "that means that every bit of our equipment from microphones to speakers will have to be completely interchangeable, doesn't it?"

"Check. All of our equipment has been purchased with that in view or adapted immediately after purchase so that every microphone, speaker, or turntable can be used with every amplifier."

"You said we are also going into the sale and installation of sound equipment on a bigger scale. Got any high-powered ideas on that?"

"Lots of 'em," Mac replied promptly. "The other day, being very hard up for something to read, I picked up a couple of the wife's home-making magazines. Imagine how surprised I was to find extensive articles in each extolling the many advantages of having a complete custom-built sound system either included in the plans for a new home or built into an older house. One writer said that in the home of a music-lover such a system was almost as essential as a heating plant!

"While I can't quite go along with that—not in this climate, anyway—I was impressed with the fact that customers are more 'high-fidelity conscious' than I realized. Obviously, the old technician's secretly-despised tin-eared public that thought its radio sounded best when all of the highs were being chopped off by an alleged tone control has suddenly come of musical age. These people are ready and waiting to be sold really good custom jobs for their homes, and it is high time we technicians woke up to the fact. The sale and installation of such a system represents a tidy profit right on the barrel-head, and the maintenance of the equipment will provide a steady source of income over the years."

"Sounds great," Barney agreed; "but how do we snag these custom jobs?"

"Mostly by letting the customer sell himself. If he once has a good chance to compare the sound of a good amplifier working into a fine speaker with the kind of audio delivered by the ordinary radio-and-record-player combination or TV s . , ne is more than half-sold. But as a clincher, we can illustrate the added convenience and economy of a custom setup."

"Illustrate?"

"That's right. In the next couple of weeks we are going to build up a couple of portable hi-fidelity demonstrator rigs. Each of these rigs will contain three separate units: (1) a rugged, well-built, three-speed turntable and a control panel, (2) a high-fidelity amplifier, and (3) a fine coaxial speaker in a bass-reflex cabinet. Cables of various lengths will be provided so that the parts may each be placed most conveniently in the individual home. Provision will be made for running the customer's radio or TV set through the amplifier so that he can hear the quality he has been missing. If he likes, we can also set in a really good AM-FM tuner at the same time."

"I can see that the customer is going to be impressed with the sound-quality and convenience of a custom job like that, but I don't quite get how you are going to show him that it is economical," Barney said slowly. "Good quality in audio equipment doesn't sell for peanuts. A high-fidelity speaker alone costs more than a whole a.c.-d.c. receiver."

"That's true," Mac nodded, "but we are going to show our customers that the money they spend for a custom job really goes into quality electronic equipment instead of expensive furni-

ture. A good, well-installed custom job will out-perform many console combinations costing two or three times as much simply because its cost has all been aimed at pleasing the ear instead of being spread thin in an effort to please both the eye and the ear.

"At the cost of an extra speaker and a little wire you can have high-quality music piped into any room in the house. Moreover, no matter what kind of a receiver you may purchase in the future, your custom audio system stands ready to give you the very best in sound reproduction from that new set."

"I saw a good example of that last night," Barney offered. "A fellow down the block asked me in to see his new TV set. He has always been a high-fidelity crank and has a fine sound system installed in his home. The new TV set was actually just a tuner that was specially designed for custom installation. A low-impedance line fed into the audio amplifier; and, Man, you should have heard that quality! It was just like being there.

"The tuner itself was mounted right into a wall, and it really made a neat installation. The picture was much better than average, too, because, as you mentioned, the manufacturer had put the money he ordinarily would have had to spend on a fancy cabinet and a mediocre sound system all into getting a good picture. The sweep circuits had refinements that made the picture steady as a rock, and the owner told me that only twenty-five microvolts of signal would produce one volt at the detector. A feature that is mighty handy for this fringe area allowed the operator to choose either a broad, high-fidelity picture i.f. or a narrowed, high-gain i.f. band-pass for use when the signal was weak. In this way, when you needed it, you could have a 10 db. boost of the signal by merely flipping a switch. That combination of high-quality tuner and high-quality amplifier makes the best TV installation I have yet seen and heard in this fringe area."

Mac stood up and stretched until his muscles cracked. "Well, Red, it looks like we could sit here and talk about this sound sideline until morning; but I guess we had better break it up, or Miss Perkins will be the only one to show up in the morning. Go on home and go to bed; or, as you hams put it, start modulating the mattress!"

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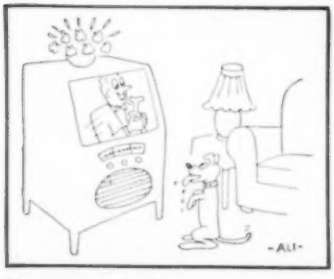


MARS Station of the Month

MARS BEAMS WEEKLY BROADCASTS

MARS—Army Headquarters station, WAR, located at the Pentagon Building, Washington, D. C., broadcasts a weekly message each Tuesday at 0100Z and at 0400Z. (This is Monday at 8 p.m. and 11 p.m., Eastern Standard Time; Monday at 7 p.m. and 10 p.m., Central Standard Time; Monday at 6 p.m. and 9 p.m., Mountain Standard Time; and Monday at 5 p.m. and 8 p.m., Pacific Standard Time.)

Simultaneous broadcasts are made on frequencies 3497.5 kc., 6997.5 kc., 14,405 kc., and 20,994 kc. Each message is sent three times, once at 10 words per minute, once at 15 words per minute, and once at a higher rate of speed—usually 20 words per minute.

Designed especially to transmit quasi-official traffic and training information to MARS members, the broadcast offers an excellent opportunity to all amateurs in building up their code proficiency.

AF6AIR/K6AIR, MARS station for Headquarters Fourth Air Force, Hamilton Air Force Base, California, has been named MARS Station of the Month by Major Rawleigh H. Ralls, Chief MARS, U. S. Air Force. The happy resolution of an unusually touchy problem is the basis for this recognition; that is the merger of base amateur club with that of MARS activities, into a strictly first class installation.

Captain Kermit R. Parker W6JFN, MARS Director for Fourth Air Force, has done an outstanding job in every department of the program. He has procured and distributed surplus on a sound basis of the membership's ability to modify it and put it into operation on a MARS net, and this took Saturday and Sunday work. He has kept a constant flow of information to his members in the form of bulletins and personal letters and has built his net participation up to the point of saturation on a number of frequencies.

With a high degree of tact he sold the old gang of hams at Hamilton on the idea of combining W6ZOE with K6AIR for a maximum utilization of the equipment. Now K6AIR is open seven days a week and is available at all times to MARS members and non-member amateurs at the base.

Parker's assistants are M/Sgt. Daniel G. Olivier, "Danny," W6IHC, in charge of supply and holds down a trick as operator, T/Sgt. Ralph N. Van Natta, "Van," W6WET, in charge of net organization, membership applications, and regular operator, and T/Sgt. William B. Coe, "Bill," K6FAK (4th Rescue Squadron) is chief operator and installer extraordinary at K6AIR/AF6AIR.

AF6AIR run skeds on 1752.5 A-1,

This is the group that installed and is operating Headquarters Fourth Air Force MARS Station AF6AIR at Hamilton Air Force Base, California. From left to right: Capt. Kermit R. Parker, AF6JFN, MARS Command Director, Fourth Air Force; T/Sgt. Bill Coe, AF6FAK, M/Sgt. Dan Olivier, AF6IHC, and T/Sgt. Ralph Van Natta, AF6WET.

and 1762.0 A-3 on 24 hour basis and a fast fone net daylight hours only on 7832.5 and drill nets and informal discussions A-1 and A-3 on 3222.5. It also keeps regular sked with AIR in the Pentagon. A heavy traffic load is handled to the Pacific and the Far East by MARS ops and K6AIR indulges in general amateur operation on all amateur bands from 160 through 2 meters.

The equipment list, in addition to that pictured, is a 100-watt two meter transmitter with v.h.f. 152 and *Super-Pro* for receiver combination, and a *Temco* 1000 for c.w. operation as well as another BC 610 used solely for 10-meter operation.

The antenna complement consists of a 900 foot long wire, and a pair of V-beams for U. S. and the Far East, a 4-element rotary beam for 10 meters and inverted L's for each of the MARS frequencies.

The whole gang at Hamilton works as a team and participates in all amateur as well as MARS activities. Creditable scores have been turned in in all contests. —30—

How to Judge Audio

(*Continued from page 44*)

cleanly and without "fuzz" or stridency, and therefore seems somewhat lower in total tone. On the other hand, the high notes reproduced on a system with a high frequency cut-off, have a dull, lackluster timbre. On a low fidelity system the triangle has a bell-like tone all right; but it is the tone of a bell which is damped by being held in the hand while struck. In a very fine system, the bell-like tone is clear and sharp, with an added brilliance, as if the bell were hanging on a non-resonant string. On a distorting amplifier, the bell-like tone has "spikes" all over it, as if the bell had been shattered by the blow and the sound of the breaking glass or metal added to the original tone.

Nowadays, with inexpensive audio generators and even more inexpensive test records, it is easy to make a frequency run on the reproducing system. Presuming such a run shows a smooth, nearly flat or absolutely flat response to 10,000 cycles and beyond, the next thing to do is to listen with the ear, while varying the volume upward, to see if the high frequencies are reproduced cleanly and without fuzz, stridency, or outright harshness. If, in addition to such cleanness, the system can be listened to for hours at a time without fatigue, you can assume you have a good high frequency response.

Voices are good tests of undistorted high frequency response. The sibilants, such as the "S's" and "Th's" and the "ce" in the word chance, should be heard plainly and cleanly. The intensity of these sibilants varies with individual voices but in the average voice is amazingly high. If the system has a good and undistorted high frequency response, the sibilants will

be reproduced plainly, loudly, and very naturally.

If the system has low distortion, the "noises" accompanying music should be audible. In the Serkin recording of Beethoven's "Emperor Concerto," for instance (*Columbia* M-500) during the solo trills and runs in the treble, it is possible to hear the thumps as the keys hit bottom. These thumps are low frequency noises but they are masked if there is high frequency distortion and their audibility is, therefore, a good check test, for high frequency distortion. A drummer's percussion instruments and effects are good material for listening tests. Especially good are the Latin American bands with their castanets, brushed drums, and various odd percussion instruments. Most of these produce not musical tones but rhythmical noise; the better the high frequency response the clearer and more natural such noises. The recording of "Dry Bones" by Waring's "Pennsylvanians" has many odd sound effects in the "noise" category which make excellent test material.

But perhaps the best single test of undistorted high frequency response is a piece of very modern symphonic music with clever dissonances. Aaron Copeland's "El Salon Mexico" (*Victor* DM-546) is a wonderful example. The word "dissonance" is not quite accurate; it is because the passages in this work are not out and out dissonances that they make such fine test material. What Copeland does in this exciting music is not to produce out and out dissonances but rather to see how close he can come to outright dissonance without actually producing it. In several passages he gets right up to the edge of the cliff, but never quite goes over into dissonance.

If the recording, which by the way is excellent and of low inherent distortion, is played on a fine system, the effect will be that intended—the music is not only not unpleasant but amusing and stimulating. A bad amplifier, on the other hand, will so change the harmonic structure that the passages do go over the cliff to become unpleasant dissonance.

Bass Response

The judging of bass response is more difficult than that of treble response. One trouble is that the ear possesses the very odd characteristic of imagining the existence of the fundamental even when it is not present, if the harmonics are strong. Even experienced and sensitive musicians are capable of being fooled by this illusion.

In general, as in the case of treble response, the fine system, at first hearing, appears to have less bass than the poor system, because it contributes less distortion and therefore has fewer harmonics of the fundamental. High frequency distortion is easily recognizable because it doesn't sound like music. But bass distortion may well sound like music to the unsophisticated ear.

Assume a bass viol playing a 60 cycle note and suppose the amplifier or speaker has strong second and third harmonic distortion. This means that it will add more 120 and 180 cycle components to those the instrument produces naturally. These harmonics sound like bass tones. Moreover, the peculiar quality of the ear mentioned before, gives the illusion that there is more fundamental, too. And all in all, it may well sound like a lot of bass and good bass too, to many ears —until a comparison is made with a genuine bass, and then the greater realism of the undistorted bass shows up.

Because the fine system has a wider response and less harmonic distortion, the fundamental will form a higher proportion of the total tone. So the bass will be duller, but more vibrant. In analogy, it will sound more like the sound produced by beating a rug, than that produced by beating a drum. If the fundamental is reproduced, the bass will sound "more like you could count the cycles per second," to quote a friend who was impressed upon first hearing a double bass viol in person. Moreover, there will be more vibration—sensible and "feelable" vibration of the air and surrounding solids. If you stand in front of a speaker system which is reproducing fundamental bass tones, you will feel your lungs vibrating even at low volume levels. The floor and walls of the room will also vibrate.

The better the bass response, the more the bass in music will "move." Most of the bass in modern music, both popular and classical, is contributed by the double-bass which has a range of many octaves. Unfortunately, the fact that speaker-enclosure systems are not merely reproducers of sound but generators as well, has often resulted in the double-bass appearing to be as stationary and as nearly "Johnny-One-Note" as the bass drum.

The explanation is very simple. Take a speaker-enclosure system with a marked resonant point around 100 cycles. That enclosure is a generator of 100 cycle tones and within certain limits it doesn't matter much whether it is stimulated or triggered by a 50 or a 100 cycle signal. It will still produce 100 cycle notes, just as a drum will produce the same note whether struck with a piece of wood or metal. So the bass will have a very high content of 100 cycle notes and will seem stationary even though the bass viol may be moving through the range of 50 to 200 cycles.

But if the resonant point of the speaker-enclosure system is lowered to below 50 cycles or eliminated entirely, it becomes much less a generator and much more a reproducer. So the bass of a bass viol will move up and down the scale and the "Johnny-One-Note" quality will be reduced or disappear entirely.

To summarize then, the bass response of a great reproducing system

will (1) be apparently lower at first hearing than that of a poor system; (2) it will be duller and deeper in timbre because it will contain a higher proportion of the fundamental; (3) it will be more vibrant, or "more like you could count the cycles per second;" (4) it will produce more sensible and "feelable" vibration of the air and solids; (5) it will "move" more and have less "Johnny-One-Note" quality.

Definition

A more characteristic quality of a fine reproducing system than the bass and treble responses—although related to both—is the quality called "definition." Audio definition can best be explained by an analogy with visual definition.

Photographers are very familiar with definition. It is perhaps the most important quality of a good camera or enlarger. A camera with good definition takes sharp, clear pictures, in which the details stand out. The individual blades of grass in a lawn, the individual hairs in a coiffure, stand out clearly and distinctly. A poor camera blurs the details.

Audio definition is exactly comparable. A system with good definition reveals the distinct, separate components of the total sound picture. Therefore, it is possible for the listener to pick out the individual instruments in an orchestra, even when they are playing the same note, and even in a loud passage or a crescendo. It will separate the individual voices in a quartet or choral group; the individual handclapping in applause; it will also show the separate components of a chord on a piano or violin.

Definition is a function of several amplifier qualities but largely of transient response. If a camera is vi-

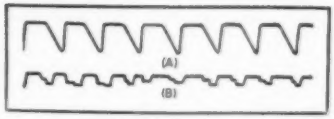


Fig. 1.

brated while an exposure is made, the resulting image will be blurred because the vibration has multiplied each line and image two or three times. Transient distortion of the type called "hangover" has a precisely comparable effect.

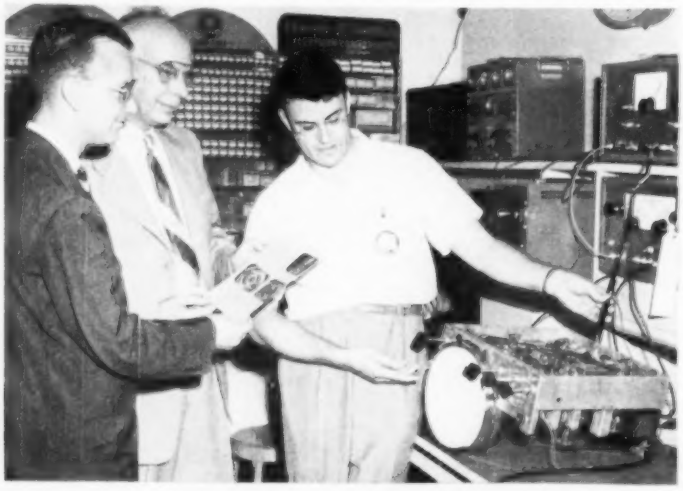
Take a run on the piano, played without depressing the loud pedal. From an *amplitude* point of view the resulting sound pattern is a series of pulses with definite intervals between each pulse, which can be represented as shown in Fig. 1A.

You will note that there are definite, discrete intervals between the separate pulses in which the amplitude is very small. But if the reproducing system is guilty of transient distortion, each note will be followed by one or more "echoes" which are generated by the reproducing system. These echoes fall in the intervals between the pulses and might be represented as shown in Fig. 1B.

It will be seen that the separation between the pulses is greatly reduced and that the pulses tend to blend into each other. This produces exactly the same type of audio blurring as vibration in a camera produces visual blurring. Such blurring greatly reduces the definition of the system.

Square-wave testing is perhaps the best objective measure of transient response and distortion, providing some means is used to include the speaker system. However, there are

Roland Kempton (right) of the General Electric Tube Divisions, explains a Tele-Clue Demonstration at the NEDA Convention in Cleveland to Arthur Stallman (center) new NEDA president, and John T. Thompson (left) manager of replacement sales for the Tube Divisions. The Tele-Clue demonstration, which was set up to show dealers how to spot TV receiver defects by means of the tube patterns, was part of the company's exhibit at the convention.



simple listening tests which give a good check for the presence of good transient response and the absence of "hangover."

The simplest is that of operating a switch whose noise is audible through the system—as, for instance, the "On-Off" switch of an associated tuner. The better the transient response the "cleaner" the tone of the noise and the shorter the time it lasts. The "cleanness" means that the thump is principally the fundamental without the addition of harmonic distortion; the short interval testifies to the lack of hangover echo.

An excellent and rigorous test is a high-speed c.w. signal tuned in *without* a beat frequency oscillator. The signal will be audible as a series of thumps. The better the transient response the more distinctly the thumps are separated. On a really high quality system, each of the thumps of a very high speed c.w. signal will be distinctly and sharply separated from the preceding and following pulses.

Piano recordings, or, better yet, an actual piano, are excellent tests of transient response. Indeed, all percussion instruments, if highly damped, are good. The kettle drums in the opening of Gershwin's "Concerto in F," for example, should be clean, sharp, and distinct. Plucked strings are very good. Look for separation of successive notes and pulses, a sharp rise and a quick decay in amplitude.

Naturalness

Naturalness is, of course, extremely important. The natural or distinctive tone of an instrument or voice is determined largely by the relation between the fundamental and the harmonics. Some of these relationships are amazing. In a typical male baritone voice, for instance, the sixth harmonic may be 10 times, or 20 db., greater in amplitude than the *fundamental*. In a violin the amplitude of the harmonics decreases rapidly with the order; but in a clarinet, the amplitude of harmonics increases and the 10th or 12th harmonic may be many times louder than the second or fourth and as loud as or louder than the fundamental.

It can readily be seen that both frequency distortion and harmonic distortion are capable of altering the harmonic structure so as to change the total character of the sound pattern and make a voice or instrument sound unnatural. Thus, if the baritone is boosted in the bass portion, the voice may be more pleasant, but it will no longer be natural, because the dominance of the harmonics has been destroyed. On the other hand, if the amplifier has great harmonic distortion, the harmonic dominance may be emphasized until it is not only unnatural but very unpleasant.

The only test for naturalness is a familiarity with the natural tone of the instrument or voice being reproduced. The simplest test is to use a good microphone and the voice of

someone whose vocal mannerisms are completely familiar.

Presence

"Presence" is a relatively new term popular in advertisements of loudspeakers and amplifiers. Definitions and analysis may differ. Presumably the term refers to that quality which gives the illusion that the listener is actually in the room in which the program is originating. Several factors combine to produce this quality. Naturalness, of course, is one of them. The audibility of various accompanying noises, such as breathing, is another. But the most important, perhaps, is the quality of room resonance.

There are always two rooms involved in the reproduction of recorded and radio sound—the room in which the program originates, and the one in which it is reproduced. It is the resonance of the original room, the studio, we are trying to reproduce. But since living rooms have acoustics which are very different from studios or concert halls, it is obviously a difficult thing to reproduce the room resonance of the original room or studio.

Moreover, the amount of room resonance present in a radio program or recording will vary widely. Up to a few years ago most radio and recording studios were very dead and the program incorporated very little resonance. Lately many radio programs and recordings contain a degree of room resonance. The degree of presence will, therefore, necessarily vary not only with the acoustics of the living room but also with the program material.

Under today's conditions it is probably best that the room in which modern musical radio programs and records are reproduced, should be slightly on the "dead" side. If the room is too live, the room resonance it contributes may so modify the total effect as to reduce the illusion of presence.

Keeping these things in mind, the first thing we can say about testing or judging sound systems for presence, is that in a given room and with a given program source, the better the amplifier—in the respects already considered—the less the apparent or superficial room resonance.

Room resonance consists largely of the addition, to the original sound, of echoes reflected from walls and other objects. But echoes are also added by transient distortion or hangover. An amplifier with good definition has a good transient response and little or no hangover; therefore, it contributes little or no artificial resonance.

This does not mean it will have less presence. No real investigation has been made of all the ways in which room resonance is expressed in the total sound picture. Part of it consists of the echoes in the same frequency range as the original sound but with phase and amplitude differences. Part, however, consists of various combination and beat tones, especially of very

low frequency, which would not be present if there were no reflected component. The more faithful the reproducing system, the more faithfully it will reproduce these complex patterns which account for the total room resonance and presence qualities. And even if there is less artificial resonance, the rendition of the resonance in the original program material is more faithful and natural.

Many of the *RCA* 45 r.p.m. records and LP's have excellent innate room resonance and presence. The best example of recorded presence we know of, however, is the recording of "Greensleeves" with Dorothy Shay. Perhaps because it is recorded in a small studio, comparable in size to the average living room, the effect of presence on a good sound system is really remarkable. Those midnight pick-ups of bands from the local nightclubs are often excellent for checking or demonstrating presence.

Dynamic Range

Because of the almost universal use of limiters and compressors in radio and recording, the dynamic range of most programs will be less than 40 db. This is considerably less than that of a live orchestra. As a result, the home sound system will seldom be called upon to deliver high output peaks. Assuming a reasonably efficient speaker system, an output of 5 watts will not be exceeded once a month. Still, the system should take those peaks cleanly and without producing excessive distortion.

A simple test for this is to use that Gershwin "Concerto" recording of the opening kettle drums. Raise the volume until the kettle drum bursts push the amplifier to nearly maximum output. Now listen for cleanness in reproduction, as compared with reproduction at low volume levels. Also for traces of echoes or hangover. If the system will reproduce those bursts cleanly, sharply and without generating echoes and bad distortion, it will easily meet the dynamic range problems of everyday listening.

To summarize then, in subjective tests of sound systems look for these factors: (1) Freedom from fatigue; (2) A clean, sharp, distortion-free high frequency response, without fuzz or harshness; (3) a natural bass in which the fundamental is dominant. Such a bass is duller than an artificial bass, more vibrant and will move more; (4) Good definition which is expressed by the distinctness with which the separate components of the sound pattern stand out from each other; (5) Naturalness of the instruments or voices; (6) Presence, or the illusion of being present in the room in which the program is originating. In a living room the illusion may be more like that of hearing the orchestra in the next room, or through a door; (7) The system should take peaks without breaking up and any distortion ought to be confined to the upper 3 or 4 db. of the dynamic range. –30–

THE AD-VISER

③ HEADLINES SHOULD PROMOTE INTEREST

By
IRVING SETTEL

AS FAR as the radio and television merchant is concerned, there is but one justification for advertising: immediate and profitable sales! This means that your advertisement must get readership, must convince the readers, must get them to act upon your suggestions. Obviously then, the first and most important problem confronting the advertiser is to get attention.

Competition within a newspaper is terrific. The average person buys a paper to read the news, to enjoy the comics, the features, and columns. The advertisements within the pages are incidental and often undesirable. It is necessary, therefore, to entice the readers from what *they* want to read to what *we* want them to read. Assuming that this can be accomplished, we find another group of competitive factors . . . other advertisements! Every advertiser is fighting for attention. All are trying to sell. All are demanding the reader's attention.

What makes the reader leave the news items, take his eyes from the comic pages, give up his favorite columnist? *The headline in the advertisement!* What element gets the reader to stop as he rushes through his paper? *The headline!* What, within the ad, offers enough interest to get the potential customer to read your copy? *The headline!*

There is no doubt about it, the headline is the most vital part of your advertisement. Not many retailers appreciate its value. Thousands of dollars are spent on advertising, on sparkling copy, and fine illustrations. But often the headline is neglected. Yet, if the headline does not attract, the copy will not be read. While the illustration does carry a good portion of the attention-getting load, it cannot do its work without an effective "head."

There are many kinds of headlines. There are curiosity headlines, news headlines, selective headlines, etc. Tests prove, however, that the one theme within the headline which gets the most attention is *self-interest*.

Every reader is interested in himself first and foremost. Everyone wants to better himself. Everyone wants health, happiness, and success. If you can offer this in your headline, you'll get his attention. You must talk in terms of what he wants, you must tell him how *he* can benefit from using your product. The result? Plenty of sales!

Self-interest headlines are the kind that get attention. Each "head" should offer as complete a thought as possible. If the reader should skip the body, and often he does, he'll be left with a valuable impression which may bring "delayed action." Remember, the best headlines offer the reader something he wants! But too, it must be simply written and understandable to every potential customer. You must catch the reader's eye, with simplicity and directness. You've got to sell, sell, sell in your headline just as much as in your body copy.

Effective Headlines

Let us review some of the rules which make for effective headlines:

1. Appeal to the reader's self-interest. Offer him something *he* wants.
2. Make your appeal believable. When you make an offer, it should be one which can be followed through in your body copy . . . and in your store.
3. Curiosity headlines are effective when combined with self-interest. Don't use curiosity alone.
4. Use a positive, cheerful approach wherever possible.
5. Before writing your headline, ask yourself what would make *you* read the ad and act upon the advertiser's suggestions. This may give you the key to the correct appeal.
6. Make your headline short and simple, easy to understand, sincere, and convincing.

Can a successful formula be applied to writing headlines? The answer is "yes," with reservations. Most good headlines are inspired. They come from the heart *and* the head of the copywriter and appeal to the heart and head of the reader. However, there are formulas which might start the train of thought in the right direction. There are also formulas which have been used successfully in the past and can be applied to your business. Here are a few of the most practical examples:

1. Start your headline with the

word *"HOW."* People are always interested in learning *how* to do things. Examples include:

HOW TO SAVE $15 ON YOUR NEW TELEVISION CONTRACT!

HOW TO ADD PLEASURE TO YOUR HOME!

2. When offering something new, start with the word *"NEW"* or *"ANNOUNCING."*

NEW. . . . AN EASY WAY TO BUY A TELEVISION SET!

ANNOUNCING. . . . SAVINGS UP TO 50%!

ANNOUNCING. . . . OPENING OF OUR TELEVISION SERVICE DEPARTMENT!

3. One word headlines are effective if they are thoughts within themselves and are printed in large bold letters:

REDUCED!
FOUND!
SAVE!

Sub-headlines are usually required with single word "heads" to amplify the meanings and thoughts.

4. Use the *question* headline to arouse curiosity but be sure to include the self-interest theme.

IS YOUR TELEVISION SERVICE COSTING TOO MUCH?

WOULD YOU LIKE TO SAVE 25% ON YOUR NEW RADIO?

5. Selective headlines with the element of self-interest will get attention:

TO WOMEN WHO WANT TO SAVE MONEY!

TO MEN WHO LIKE TO STAY HOME EVENINGS.

Originality and common sense must be included in all your headlines. Your own business experience and judgment help a great deal. But time must be spent to get the best "head" for you must not forget that it carries the heaviest load in attracting attention. —30—

One of the 114 microwave relay reflectors being built by General Electric for the communications system the company is supplying Transcontinental Gas Pipe Line Corp., to extend over its 1840-mile pipe line now under construction between Houston and New York. Project Engineer M. F. Davis finishes installation of the dipole prior to tests being made at G-E.

Hum Control

(Continued from page 58)

120 cycle note. Hum due to inadequate cathode bypassing, or an ungrounded heater supply, is often an asymmetrical 60 cycle wave with sharp corners, Fig. 8B.

Inductive hum picked up by transformers is very rich in harmonics (Fig. 8C) but free from sharp peaks and spikes. It has a sort of musical sound, like the hum sometimes heard on telephone lines.

Fluorescent lamp interference is characterized by sharp spikes and hash. Fig. 8A shows a bad case of it. The frames of the fluorescent lamps that are placed near the bench should be well grounded, and the lamps themselves kept at least a couple of feet from the work.

Miscellaneous Sources

Broadcast receivers sometimes exhibit hum only in the presence of a received carrier. This is due to rectification of r.f. picked up by the house wiring, by copper oxide in loose connections therein. The rectified signal is modulated by a.c. The remedy is to eliminate r.f. signals getting into the set from the a.c. line, by grounding both sides of the line to the chassis through condensers of about .005 μfd.

The v.h.f. oscillators, such as oscillators in FM and TV receivers, acquire a 60 cycle frequency modulation in circuits where the cathode is "hot" to ground and the heater is not, *i.e.*, where cathode and heater are not at the same r.f. potential. The mechanism of this effect is not understood. The cure is to use a circuit where cathode and heater have the same r.f. potential. It is satisfactory to use either a grounded-cathode oscillator circuit, or a "hot" cathode circuit where cathode and heater are connected together, feeding the free side of the heater through an r.f. choke.

Center-tapped heater supplies are not too feasible in systems involving high-gain, multi-stage r.f. or i.f. amplifiers, because one side of the heater has to be grounded at each tube, preferably right to the chassis, to prevent regeneration by coupling through the common heater wiring.

REFERENCE

Dickerson, A. F.; "Hum Reduction," Electronics, December 1938, pp. 112-116.

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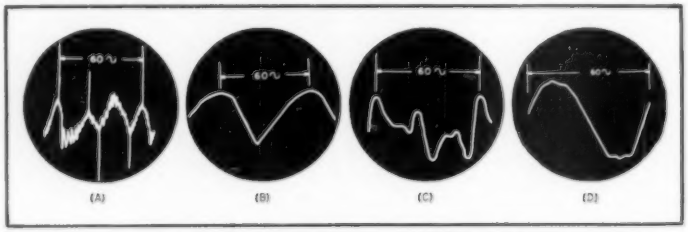

Fig. 8. (A) Noise pickup from fluorescent lamp. (B) Heater-cathode leakage current. (C) Inductive hum pickup by audio transformer. (D) Capacitive hum pickup from a.c. wiring.

Officers of the 1951 Radio Parts & Electronic Equipment Shows recently met in White Sulphur Springs to make plans for next year's expanded program of displays, exhibits, and meetings. From left to right are: I. J. Kahn, Standard Transformer Corp., president; L. W. Howard, Triad Transformer Mfg. Co., secretary; S. J. Spector, Insuline Corp. of America, vice-president; and C. A. Hansen, Jensen Mfg. Co., treasurer.

International Short-Wave

(*Continued from page 154*)

Pakistan—*Radio Pakistan* noted with news 0700 on 7.140, approximately 11.54, and 11.845. (Sanderson, Australia) The 11.54A outlet is best here in West Virginia at that time.

Panama—HP5J, 9.607, Panama City, noted with music 1930, weak and with QRM from BBC. (Cox, Delaware) HOLA, 9.505, Colon, heard in *English* 1600-1730. (Colby, Conn.)

Paraguay—ZPA1, 6.275, Asuncion, heard in Sweden quite well at 1950. (Orhwall) ZPA5, 11.945, Encarnacion, is a good signal 2000-2100. (Sutton, Ohio)

Peru—*Radio America*, OAX4W, 9.63, Lima, noted with good signal around 1815 to fading around 1900; all-Spanish. (Boice, Conn.) *Radio Nacional del Peru*, OAX4Z, 5.895, signs off 2330, good level; then OAX4V, *Radio America*, 5.907, comes into the clear with good but weaker signal; latter leaves the air 0100. (Callarman, Oregon)

Philippines—DYB2, 4.98, Bacolod City, noted 0830 with classical music; DYH2, 6.140, Cebu City, heard 0830 concluding program of dance music; DZH6, 6.030, Manila, the Far East Broadcasting Company, heard 0830 with news in parallel with DZH7, 9.73. (Neeley, Oregon) DZH2, 9.64, Manila, noted signing off 1100; DZH3, 9.500, heard 0500. (Baker, Calif.) DZH5, 9.69, heard 0530 with music, then news; sponsored. (Sanderson, Australia)

DYH4, 6.055, noted 0615 with music. (Sanderson, Australia) This one verified from Dumabuete City; has been operating *only* at 0500-0700 on DYH4 and DYSR (840 kc.), but schedule by now probably will have been extended to four hours daily; power is 300 w., with V-beam on Luzon; location was first believed to be Iloilo City. (Cushen, N. Z.)

Poland—Warsaw now has a *second* transmitter on the air; uses 6.215, 7.205, 9.252; *English* is at 1215-1245 on 6.215 and 9.525, at 1330-1400 on 6.215 *only*. (Radio Sweden) The 9.252 channel has been heard in New York to closing 1815 and again from 2000, good level. (Bellington)

Portugal—Lisbon's *new* channel on approximately 15.02 is heard afternoons in dual with 11.04 to 1530 closedown; these outlets come back on the air 1600-1800 final closedown. Is also heard on 15.02 early mornings EST. (Bellington) *Radio Sweden* lists the 15.02 outlet as CSA34.

Roumania—At the time this was compiled, *Radio Bucharest*, 9.252, was beginning to come through again with news 1500; heavy CWQRM on channel. (Cox, Delaware)

Saudi-Arabia—Djeddah, approximately 3.91, heard through QRM at 1200-1330 (some days late as 1400); clock strikes at 1330; male and female announcers. (Hannaford, South Africa) Heard by Pearce, England,

around this time on approximately 5.975.

Bellington, N. Y., has received a most interesting letter-verification from Djeddah's chief engineer, John E. Morrow (formerly W9RAT—the "Old Kansas Rat"). The transmission at 2300 is heard by Bellington best on 11.75, but other channels audible include 11.85, 11.95, and 9.635; Morrow also listed 3.950.

South Africa—Since SABC no longer takes BBC news relays, it has set up its own news services as follows—*English*, weekdays, 0015, 0615, 1100, 1200, 1515, Sundays 0100, 0600, 1100, 1515; Afrikaans, weekdays, 0000, 0630, 1115, 1215, 1510, Sundays 0110, 0545, 1105, 1510. (Copenhagen DX broadcast) ZRB, 9.11, Pretoria, noted 0015 with news. (Bellington, N. Y.)

Southern Rhodesia — Salisbury has been testing a 1 kw. transmitter on 9.490 and an 8 kw. one on approximately 6.078; regular channel remains 3.320. (Radio Australia) Heard by Pearce, England, on 3.320 to 1501 when signs off with "God Save the King"; local news 1315, weather, then SABC news.

Spain—Madrid, 9.369, is good signal in Connecticut daily 1800-1840 in North American (*English*) beam; on Sundays has a mailbag program called "Forty-Minute Trip Around the World"; an interesting talk on Spanish Africa is presented each Monday. (Boice) Still heard with news for Europe 1515. (Fargo, Ga.) EAJ3, *Radio Mediterraneo*, 7.037, Valencia, has *English* lessons on Tues., Fri. 1440.

Syria—Radio Damascus verified via airmail; gave schedule of Thursday 2345-0300, 0400-0800, 1100-1700; Saturday 2345-0300, 0430-0800, 1100-1800; other days 2345-0100, 0600-0800, 1100-1700; present frequencies were listed 6.000, 9.550, 12.000; news 0600, 1630 daily. (Cushen, N. Z.)

Tahiti—A recent letter from *Radio Tahiti*, Papeete, stated that by the end of 1950 two transmissions are to be radiated for Oceania, around 1700-1745, 2300-2345; will move from present 6.980 to approximately 7.300 for these transmissions; early in 1951, will use 9.053 (instead of current 12.080) with 24 kw. for broadcasts to the United States at least semi-weekly and possibly daily. New studios and equipment are being installed. (Russell, Calif., Cushen, N. Z.)

Taiwan—Neeley, Oregon, says Taipeh, 12.235, is QRM'd by Moscow and WLWO, 15.23, to around 2245; is scheduled 2200-2400, first hour in *English*. *Radio Australia* reports this one back on 11.735 mornings EST; should have news either 0515 or 0615.

BCAF, 8.996, Teipeh, is heard to 1113 sign-off, weak; all-Chinese; CWQRM from numerous U.S. military outlets. (Neeley, Oregon) Noted on Wednesdays 0615 with *English*-Chinese lesson. (Sanderson, Australia)

Tangier—Radio Sweden reports that *The Pan-American Radio* has been heard testing on approximately 15.050 at 0700-0730, with announcements in

Spanish and *English;* says is owned and operated by the International Banking Corporation of Tangier.

Thailand—Bangkok currently is using approximately 6.010 (only one heard here in West Virginia; fair), 11.910, and 15.910 for the overseas broadcast in *English* daily 0500-0630; news 0515, 0615. (Sanderson, Australia)

USA—The *Voice of America* has increased its languages to 25; latest added was Vietnamese for Indo-China. (Boilard, Mass.)

Verification was received recently from Coast Guard Station NMY, East Moriches, Long Island, New York, for report of transmission on 2.698.

USI—Kuta Aradja, Sumatra, 8.910, has been heard signing off 0930; weak signal and CWQRM from DUM, Philippines; sometimes plays *English* recordings. (Neeley, Oregon)

Menado, 9.84, Celebes, noted 0705 announcing as "Radio National Indonesia"; excellent signal in Delaware. (Cox) Sanderson, Australia, lists this one currently as on 9.845, heard 0710 with music, then news in Dutch; program for troops. Stark, Texas, notes Makassar, 9.55, Celebes, at 0630.

Djakarta's YDF, 6.045, is like a local some days around 0730-0830 in native language. (Raith, Calif.)

USSR—Current schedules of *Radio Moscow* to North America are 0800-0830, 17.84, 15.18, 11.96, 11.82; 1820-1930, 2000-2300, 15.23, 15.18, 15.11, 11.96, 11.83, 11.71, 9.69. Is also good signal here in West Virginia around 0900-0945 to Southeast Asia, news 0900.

Heard in Georgia on 11.71 with talks in *English* 1430. (Fargo)

Vatican—HVJ, 17.445, is good in Newfoundland on Tuesdays 1030 in *English* for Far East. (Peddle)

Venezuela—YVKR, 4.920, *Radio Caracas*, signs off 2330; *no English noted.* (Callarman, Oregon)

Yugoslavia—Radio Belgrade, 9.505, still has news 0045. (Bellington, N. Y.)

* * *

Last Minute Tips

The Arabic-speaker on approximately 6.770 daily 1300-1500 may be ZNR, Aden, returned to the air (?). (Radio Sweden)

A Spanish-speaking station heard on approximately 8.985 with CWQRM *after* 2200, announces HRXW, may be Honduras (?). (Stark, Texas)

Radio Sweden reports on unidentified station—probably Greek—on approximately 5.940 with news 1500.

At the time this was compiled, I had just received a flash from Schilling, Calif., that he had picked up *Radio Seoul*, Korea, on 7.933 at 2350; signed off 0000 and announced as "the Democratic Peoples Republic of Korea"; woman announcer spoke good *English;* may have been a special broadcast as was not heard on subsequent nights.

Akashvani, Mysore (India), operates on 6.065 (listed 6.026; moved?) at 2030-2200, 0230-0400, 0700-1130; has news relays from AIR, Delhi, at 2130,

0300, 0730, 1030. (Copenhagen DX broadcast)

When this was written, *Radio Eireann*, 17.84, was being heard irregularly with news 1230. (Cox, Delaware) So far the *new* 100 kw. station had not been reported with "promised" tests.

According to *Radio Sweden*, "*Radio Free Europe*" is located in Western Germany and broadcasts to all countries under Communist control; reported as operating 0700-1300 on 6.135, daily. Programs are prepared in studios in New York City. Several (probably six) additional transmitters are planned. I have been promised further details by officials of *National Committee for a Free Europe, Inc.*, Room 301, 350 Fifth Avenue, N. Y. C.

The Far Eastern Broadcasting Company, Manila, Philippines, has been heard testing over DZH8, 15.300, to 1105 sign-off; fair signal but almost buried at times under BFEBS, Singapore, same channel; DZHS announces is operating in the international shortwave band on 15.3 by permission of the Radio Control Division of the Philippine Republic. Asks for reports on quality and signal strength to Station DZH8, Far Eastern Broadcasting Company, Manila, Philippines; reminds listeners of transmissions over DZAF, DZH6, and DZH7; plays mostly religious music with announcements after each song. (Neeley, Oregon) Heard by Balbi, Calif., testing 0000-0100 and other times; best at 0915; has frequent announcements in *English*.

An airmail flash from Orhwall, Sweden, says he has definitely identified the station heard afternoons EST (around 1300-1400) on approximately 6.015 as Salisbury, Southern Rhodesia; improved signal more recently resulted in his reading the announcement, "This is Rhodesia calling from Salisbury."

Radio France Asie ("The Voice of France in the Far East"), Saigon, sent this schedule for *English* broadcasts—1745-1800, first news broadcast; 1930-2000, 15 minutes of music, then second news broadcast; 0415-0515, talk and music, then third news broadcast; 0545-0600, fourth news broadcast; 0900-1015, fifth news broadcast, then music; all sessions are radiated on

FREAK TV RECEPTION PROVIDES INTERESTING VIDEO FARE

ONE of the interesting phenomena encountered by televiewers is that of "freak reception." Theoretically, television reception should be limited to locations within "line of sight" of the transmitter, but this has not proven to be the case.

We have received an interesting report of television DX-ing from Burns J. Tobias of Millersburg, Pa., which seems to indicate that distance is no handicap to the video enthusiast.

The TV station nearest to Mr. Tobias' home town is WGAL in Lancaster, some 45 miles away. The terrain around Millersburg is hilly. He uses a Du Mont 19" "Fairfield" Model RA110 receiver, two Regency boosters, and a Taco antenna. The antenna is a three-section unit with the top Yagi array cut for Channel 4, the middle section (of 4 sets of rods) cut for the high band, while the bottom array is a Yagi cut for Channel 6. The entire unit is rotatable and is mounted 75 feet above the ground.

Mr. Tobias has compiled the accompanying table covering his DX-ing experiences. Needless to say, some of the distant stations provide good reception while others are mediocre but the fact that some of the stations are received at all is somewhat unusual.

He reports that most of the extremely distant stations are only received at night although daytime reception of Miami (4), San Antonio (4), and Oklahoma City (4) are commonplace. Oklahoma City pops up on the screen most often and the reception is usually good.

—30—

Table of TV stations received by Burns J. Tobias of Millersburg, Pa.

STATION	CITY	DISTANCE	CHANNEL NO.	RECEPTION
WGAL	Lancaster	45	4	Good
WMAR	Baltimore	80	2	Fair
WBAL	Baltimore	80	11	Poor
WAAM	Baltimore	80	13	Poor
WJAC	Johnstown	100	13	Poor
WPTZ	Philadelphia	100	3	Fair
WFIL	Philadelphia	100	6	Very Good
WCAU	Philadelphia	100	10	Poor
WNBW	Washington	100	4	Poor
WATV	Newark	150	13	Fair
WDTV	Pittsburgh	164	3	Poor
WCBS	New York	165	2	Fair
WNBT	New York	165	4	Fair
WABD	New York	165	5	Poor
WJZ	New York	165	7	Poor
WOR	New York	165	9	Fair
WPIX	New York	165	11	Fair
WBEN	Buffalo	196	4	Poor
WOI	Ames	882	4	Good (at times)
WDAF	Kansas City	956	4	Fair
KOTV	Tulsa	1059	6	Poor
WTVJ	Miami	1127	4	Good (on occasion)
WKY	Oklahoma City	1157	4	Good (most often received)
KLEE	Houston	1408	2	Good
WOAI	San Antonio	1555	4	Poor

11.83 and the first two (1745-1800, 1930-2000) are transmitted also at 6.165. (Baker, Calif.)

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Press Time Flashes

Current schedules of *Radio Australia*, just received airmail, include 1500-1800 (Sat. to 1815), to British Isles and Europe, VLC, 15.20, VLA8, 11.76; 1529-1800 (Sat. 1559-1815), to Japan, North Pacific Islands, VLB11, 15.16; 1800-1950 (Fri. 1800-2100; Sat. 1815-2100), to S.E. Asia (Malaya), VLC, 15.20; 1815-1950 (Fri. 1815-2100; Sat. 1828-2100), to South and S.E. Asia (India, Pakistan, Malaya), VLA10, 17.84; 1950-2230 (*not* Fri. or Sat.), to S.E. Asia, and N.W. Australia, VLG11, 15.21; 2145-2315 (Fri. 2100-2145; Sat. 2100-2315), to Japan, North Pacific Islands, VLB5, 21.54; 2145-2315 (Fri. 2100-2315; Sat. 2100-2315), to S.E. Asia (Malaya), VLC, 15.20; 2145-2330 (Fri. and Sat. 2100-2330), to South and S.E. Asia (India, Pakistan, Malaya), VLA10, 17.84; sporting, *only* Fri. 2145-Sat. 0230, to Japan, North Pacific Islands, VLB5, 21.54; 2330-0045, to South and S.E. Asia, VLA10, 17.84, and to Africa (*not* Fri.-Sat.), VLB5, 21.54, and to North America (West Coast), VLC, 15.20; 0045-0155, to South and S.E. Asia, VLA10, 17.84; 0100-0140 (in French), to Tahiti, VLG11, 15.21, and to French Indo-China, VLC, 15.20; 0155-0315, to British Isles, Europe, and Southern Asia, VLA10, 17.84, and to British Isles, New Zealand, VLC4, 15.32, and to British Isles, Europe, New Zealand (*not* Sat.), VLB3, 11.76; 0200-0230 (Fri. *only;* in Thai), to Thailand, VLG11, 15.21; 0245-0345 (French), to New Caledonia, VLG11, 15.21; 0328-0630, to Japan, North Pacific Islands, VLA6, 15.20; 0328-0450, to N. Asia, Japan, VLB4, 11.85; 0328-0530, to South and S.E. Asia, VLC4, 15.32; 0500-0630, to S.E. Asia, VLB4, 11.85; 0530-0600 (in Indonesian), to Indonesia, VLC4, 15.32; 0600-0630, to South and S.E. Asia, VLC4, 15.32; 0630-0855, to Japan, North Pacific Islands, VLA6, 15.20; 0630-0900, to South and S.E. Asia, VLB4, 11.85; 0700-0900, to North America (East Coast), VLC4, 15.32; 0900-1000, to South and S.E. Asia, VLB4, 11.85; 0900-1000, to British Isles and Europe, VLA6, 15.20; 0900-1000, to North America (Central and Mountain Zones), VLC4, 15.32; 1000-1115, to South and S.E. Asia, VLB4, 11.85, and to North America (West Coast), VLC4, 15.32; 1015-1115, to Africa, VLA4, 11.77. In addition, VLG, 10 kw., is scheduled for use in the Overseas and Inland Short-Wave Services as follows—1500-1930 (Fri. 1500-0045; Sat. 1600-0045), VLG11, 15.21, to New Guinea; 1950-2230 (*not* Fri. or Sat.), VLG11, 15.21, to S.E. Asia and N.W. Australia; 2245-0045 (*not* Fri. or Sat.), VLG11, 15.21, to New Guinea; 0100-0140, VLG11, 15.21, to Tahiti (in French); 0200-0230 (Fri. *only*), VLG11, 15.21, to Thailand (in Thai); 0245-0345, VLG11, 15.21, to New Caledonia (in French); and 0359-0830 (Sat. to 0900), VLG10, 11.76, to New Guinea.

The 1950 Edition of *World Radio Handbook* should be available this month or next from Ben E. Wilbur, 32 Whittlesey Ave., East Orange, New Jersey. Is compiled by O.-Lund Johansen, Copenhagen, Denmark, but is entirely in *English.*

Latest schedules of Canada's International Service are—*European Service*—0915-1130, CKNC, CKCX; 1130-1545, CKNC, CKCS; 1545-1600, CKCS; 1600-1830, CKCS, CHOL. *Australian* Service—2050-2320 (*except* Sat. and Sun), UN commentaries, CKLX, CHOL; 0340-0530 (Sun. *only*), CHOL, CKLO. *Caribbean & Latin American Service*—1850-2045, CKRA, CKCX; 2045-2100, CKRA; 2100-2235, CKRA, CKLO. Outlets are CKNC, 17.82; CKCS, 15.32; CKCX, 15.19; CKLX, 15.09; CKRA, 11.76; CHOL, 11.72; CKLO, 9.63.

A station heard by Bluman, Israel, on 6.017 at 1200 may be Monrovia, Liberia. (Radio Australia)

PJC2, 5.010, Willemstad, Curacao, has *English* Mondays *only* at 2000. (Ferguson, N.C.)

A *new* outlet is TGNA, 6.039, heard at 2205; has announcements in *English* as well as Spanish; relays TGN and usually closes down around 2215; asks for reports to P.O. Box 601, Guatemala City, Guatemala. (Ferguson, N.C., and Callarman, Oregon)

Another *new* station is HRXW, 8.982, noted 1710; relays HRX announced as 1200 kc., and announces as "Radio Comayagua"; news in Spanish 2200; usually signs off around 2257; good level when clear of QRM. (Ferguson, N.C., and Stark, Texas)

At press time I had just received word direct from Harry Mahool, Deputy Director, Radio Free Europe, 311 Empire State Building, New York 1, N. Y., that *Radio Free Europe* broadcasts daily from its transmitter in the U.S. Zone in Germany (overseas sources say from Frankfurt) at 1200-1800 over 6.130 with 7.5 kw. The wavelength is 48.94 m. It is presumed that the language of the country to which it is beamed is used at present during periods to various countries. Schedule is 1200 music; 1400 to Czechoslovakia; 1420 to Poland; 1440 to Hungary; 1500 to Bulgaria; 1520 to Roumania; 1540 music; 1600 to Czechoslovakia; 1620 to Poland; 1640 to Hungary; 1700 to Bulgaria; 1720 to Roumania; 1740 music; 1800 closedown. *Radio Free Europe* is a division of the *National Committee for a Free Europe, Inc.* I understand its purpose is to get word about the "American way of life" into Iron-Curtain countries.

Pan American Radio, Tangier, has been testing 0700-0730 *only* on 15.050; various alterations are being made to antennas at this station. (Radio Sweden)

Ankara should soon be using TAP, 9.465, again for its Mailbag Program on Sundays and be back on standard time—that is, at 1630. When this was compiled it was still heard over TAQ, 15.195, at 1530.

Cox, Delaware, flashes that the

French-speaker signing on 2230 on 9.515 is *definitely Radio Tananarive*, Madagascar; he heard "Ici Radio Tananarive" announced for several nights in a row.

Although FK8AA, Noumea, New Caledonia, has been reported moved to approximately 6.010, it was still on measured 6.0346 at 0530 when checked by Oskay, N. J., at the time this was compiled; sign-on is believed 0200.

SRI, Buenos Aires, Argentina, has made a few schedule changes; LRS, 11.88, is now scheduled 0900-2230 (from 0800 Sun.); in Portuguese 0900 (from 0800 Sun.)-1200; German 1200-1300; Italian 1300-1400; *English* 1400-1500; Swedish 1500-1600; French 1600-1700; German 1800-1830, and Portuguese 1930-2230. LRU, 15.29, is scheduled 1215-1545 and 2100-0100 with *English* 1215-1330; Spanish 1330-1445, and Italian 1445-1545; the 2100 transmission is still entirely in Spanish. LRY, 9.455, is scheduled 1600-1750 (1600-1700 in Spanish, 1700-1750 in *English* for Europe), and 2115-0100 in *English* for North America. (Callarman, Oregon)

Bellington, N. Y., has recently noted FBS, Middle East, Malta, on approximately 6.02 in parallel with 7.22 from 2300 sign-on.

The Wednesday DX sessions from Leopoldville, 9.767, are now at 1410 and 2210. (Copenhagen DX broadcast)

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Acknowledgement

Thanks, fellows, for the FB reports during the summer. Now that we're entering the winter DX season, let's have more good reports to 948 Stewartstown Road, Morgantown, West Virginia, USA. . . . . KRB.

A new cathode-ray tube tester adapter, designed to be used in conjunction with any Sylvania tube tester, makes possible the checking of almost all of the electromagnetic cathode ray tubes without removal from the receiver. Approximately 85% of cathode-ray troubles may be detected by use of this adapter. Shorts, leakage, open heaters, and relative emission may be checked. The assembly consists of a cable, complete with socket and plug. W. G. "Pat" Patterson here shows the new unit to Harold Rainier, also of Sylvania.

AFCA NEWS

This Association is a patriotic non-profit organization, with chapters in most of the larger cities, dedicated to developing and maintaining efficient personnel, commissioned, enlisted, civilian, for the supply (including design and development), installation, maintenance, and operation of communications and electronic equipment for Army, Navy, and Air Force and their supporting civilian activities. It publishes a magazine "SIGNALS" at its national headquarters in Washington. Every American interested in any way in communications is eligible and invited to join. Dues are $5.00 per year. Application should be submitted to the secretary at 1624 Eye St., N. W., Washington 6, D. C., who will furnish details upon request.

Summer Camp Awards

The AFCA annual award to the outstanding ROTC communications cadet attending summer camp was presented at Fort Monmouth, N. J., the Signal Corps camp, and at Scott Air Force Base, the Air Force communications camp.

The winner at Fort Monmouth was Wilbur J. Jensen of New Brunswick, N. J., Rutgers University undergraduate. The presentation was made by Brig. Gen. Carroll O. Bickelhaupt (Ret.), national AFCA vice-president and vice-president of *American Telephone & Telegraph*, during the final review on July 27th which closed out the six weeks of training.

Cadet George A. Lovell, Jr., Waterloo, Iowa, attending Iowa State College, received the award at Scott Air Force Base during the formal ceremonies on August 4th.

The award in each case consisted of the AFCA medal, a citation certificate, a lapel emblem for civilian wear, and a year's honorary membership in the association.

Civil Defense

AFCA national headquarters has been acting in an advisory capacity to the Labor Department on a study being conducted on electronic and radio manpower. It has also assisted Leighton Peebles, communications expert of the National Security Resources Board, with communications aspects of civil defense planning. All AFCA chapters have been advised by headquarters to assist in local civil defense plans. A number of chapters already report that their services have been offered to the local authorities.

AFCA CHAPTER NEWS

Augusta-Camp Gordon

The *Southern Bell Telephone & Telegraph Company* was host to the Augusta-Camp Gordon Chapter for its August 11th meeting. The evening was devoted to a demonstration tour of the telephone company plant in Augusta.

Boston

A membership drive, headed by John B. Russell of the *S. H. Couch Company*, has been inaugurated by the chapter. Reactivated in April, 1950, under the leadership of Rear Admiral T. F. Halloran of the *General Communication Company*, the Boston Chapter has steadily increased in size and activity so that it is now one of AFCA's best units.

Columbus

A new AFCA chapter is being organized in Columbus, Ohio, under the leadership of Kenneth C. Goodman of Station WBNS-TV. Plans are now underway for an organization meeting of all AFCA members and other communications-minded people in the area.

Philadelphia

Harry A. Ehle, vice-president of *International Resistance Company*, has been elected president of the Philadelphia Chapter of AFCA. Other officers chosen for the ensuing year are: 1st vice-president—Leslie J. Woods, vice-president, *Philco Corporation;* 2nd vice-president—Russell E. Cramer, Jr., vice-president, *Radio Condenser Company;* secretary—J. R. Curley, *RCA-Victor Division;* treasurer—Henry E. Wirth, Signal Corps Stock Numbering Division.

Rochester

An AFCA chapter is now being lined up for the Rochester, N. Y., area. Joseph C. Wilson, president of the *Haloid Company* (manufacturers of photographic products), has accepted the chairmanship of a committee to perform the organizational work for the local unit.

St. Louis

The St. Louis Chapter, inactive for the past year, is being reactivated under the leadership of Col. G. E. Popkess who organized the chapter in 1947 and served as its first president.

San Francisco

The Board of Directors of the San Francisco Chapter met on August 3rd to determine the course of action to be taken by the chapter in connection with the current activities in civilian defense and disaster relief. After a thorough discussion it was decided that

the only services the chapter had to offer were those of consulting and planning in the communications part of local civil defense plans and Chapter President Harry E. Austin, of *RCA-Victor Division*, was authorized to offer such services of the chapter to the San Francisco Disaster Council and the Alameda County Disaster Council.

South Carolina

AFCA's National Executive Secretary George P. Dixon was guest speaker at the South Carolina Chapter's annual meeting at Columbia on August 2nd. Chapter President Fred M. Fister of the *Southern Bell Tel & Tel* presided and introduced the various guests which included Ralph Grist, president of the Atlanta Chapter; William H. Mansfield, AFCA national director and past president of the Atlanta Chapter; Colonel Henry J. Hort, president of the Augusta-Camp Gordon Chapter; and Hugh A. Fleming, past president of the Augusta-Camp Gordon Chapter.

Colonel Dixon's talk on the past, present, and future of the AFCA was well received and resulted in a general discussion of some of the points raised.

New chapter officers were elected as follows: President—John L. H. Young, *Southern Bell Tel & Tel*, Charleston; 1st vice-president—Samuel A. Ferguson, University of South Carolina; 2nd vice-president—Comdr. Julien J. Edgerly, Charleston Naval Shipyard; secretary—Carl E. Newman, *Southern Bell*, Columbia; treasurer—Jack Pickell, *Southern Bell*, Charleston.

Washington

In preparation for chapter activities in the fall, Comdr. Guy M. Neely, chief engineer of the Office of the Director of Naval Communications, was appointed chairman of the membership committee; and Colonel Percy G. Black, vice-president of *Gary Services*, was appointed chairman of the program committee.

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BIG HAMFEST

THE Federation of Long Island Radio Clubs Inc. will hold its 14th Annual Hamfest at Lost Battalion Hall in Elmhurst, Long Island on November 9th at 8 p.m. Admission to the affair is $1.50 if tickets are bought in advance or $2.00 at the gate.

The event will feature entertainment, prizes, and technical talks by men prominent in the amateur field.

Tickets may be obtained from any of the clubs in the Federation (Astoria Radio Club, Amateur UHF Club, Grumman Amateur Radio Club, Nassau Radio Club, Sunrise Radio Club, Tryon Radio Club, and Tuboro Radio Club), selected radio stores, and from the secretary, Thomas S. Black, W2-JSV, 3417 124th Street, Richmond Hill 18, Long Island, New York.

Officers of the sponsoring group are Robert Cross, W2FNI, president; John Cuches, W2ESZ, vice-president; William Kunzler, W2AVI, secretary; and Thomas S. Black, W2JSV, secretary.

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Sound on Wheels

(Continued from page 78)

gram material will tend to mask out the desired signal as it arrives at the listener's position. Reducing the affected range and boosting the unaffected bands (using the amplifier treble and bass controls) sometimes assists in reducing the "apparent" distortion or interference of the noise.

Loudspeaker Stand

The stand mechanism itself is quite interesting. It is constructed almost entirely of 1" angle irons and 1" pipe, with all sections welded. The principle is simple. The shaft which mounts the loudspeakers runs through the center of the stand. As the four legs are spread, the sleeve pipes apply pressure to the shaft, thus holding it secure. The shaft, being itself of considerable length, can be adjusted to any convenient height or direction by merely setting it to the desired position before spreading the stand legs full out. The weight of the loudspeakers, instead of being a burden, in this case serves to tighten up the stand. The legs are $\frac{3}{4}$" pipe, cut to any desired length and slipped into the sleeve pipes.

Amplifiers

Three amplifiers are aboard the "Studio." One is a 60 watt *Rauland* W-861 which is the main unit used. It is mounted in a *Bud* metal cabinet together with a 30 watt *Rauland* W-835-A which serves as both an alternate and a standby unit. These amplifiers operate from 115 volts a.c. only, and are located directly to the right of the operator, as illustrated in Fig. 9. A third 30 watt amplifier is located just above the power plant and 12 volt inverter. It is a dual voltage unit capable of operating from either 115 volts a.c. or directly off 6 volts d.c. (see Fig. 2). Four mike and two phono inputs (all high impedances) are provided by each amplifier, as well as a three position microphone remote control receptacle. The usual complement of tone, mike, and volume controls are provided and are available to the operator at the front panels.

Changeover Switch

Of particular interest is the amplifier changeover switch. Fig. 11 illustrates the cabinet containing the main and standby amplifiers, with the handle-operated instantaneous changeover switch mounted on one side of the cabinet. All the input and output connections of both amplifiers are run to a 12-gang, cam-operated, single-circuit, double-throw *G-E* switch assembly (CR1070-E105) which, at the flip of the handle, throws either one of the amplifiers into the operating circuit.

So that warm-up delay may be eliminated, the ground return lead of the amplifier power transformer's high voltage winding center tap is brought

out from each amplifier to a section of the switch. The filaments of the standby unit remain lit, and the amplifier goes immediately into action as its high voltage ("B—") is returned to "ground."

Jones plugs and receptacles are used to connect program equipment to the switch. The binding posts feed the amplifier output to the loudspeaker load. Note in Fig. 9 that the turntables and recorders are located atop the engine housing and that the amplifier cabinet is directly alongside. The outside microphone and speaker connections feed from the roof-top connectors to the overhead glove compartment and down to the switch panel. The tuner output is also routed through the glove compartment which serves quite well as a storage place for program input cables arriving from various points of the truck.

Tuner

The tuner is a *Meissner* Dual Band 10-1151, flush mounted on the right side of the cab back wall. A monitor speaker is provided for tuning and monitoring. If announcements are being made from the cab, earphones are used in place of the speaker. Normally, the tuner output, when used, is channeled to one of the "phono" inputs of the p.a. amplifier. However, it is also possible to use the tuner independently of the p.a. system to record a special program off the air onto one of the wire recorders for playback through the p.a. system later on.

To present a suitable impedance to the high impedance input of the recorder, the tuner signal was tapped just ahead of the coupling condenser between the 6H6 2nd detector and 6F8G 1st audio and fed through a .002 mfd. blocking condenser to an outlet improvised on the tuner chassis. The return circuit is grounded. The level at this point was found to be more than enough for the amplifier. A 12' extendable whip antenna is used. It may be seen in Fig. 12 mounted on the base of the roof-top platform.

Recorders

Two *Webster-Chicago* one-hour capacity wire recorders are used. Here again it was necessary to improvise a bit to feed the proper level and impedance from the amplifier to the high impedance recorder inputs, in order to record the program going out through the p.a. system. The signal being developed across the 250,000 ohm grid leak resistor of the 3rd audio 6SC7 of the amplifiers was found satisfactory, and was brought out to a receptacle at the rear of the amplifier chassis. The recorder inputs are paralleled so that if the program being recorded exceeds one hour, it may be immediately picked up by the second unit. Where a recording is especially important, both units may be used simultaneously as a safeguard against possible trouble with one of the recorders. Normal procedure has been to use the playback system of one of the recorders

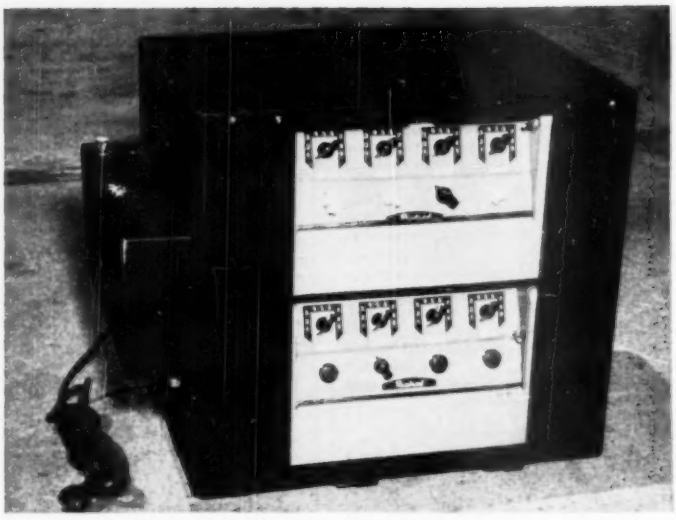

Fig. 11. Cabinet housing main and standby amplifiers. A handle-operated instantaneous changeover switch is mounted on one side of the cabinet, as shown in photo.

to monitor the output of the p.a. system, while the other unit is prepared and ready to record should some unusual occurrence dictate its immediate use.

For playback, the high impedance outputs of the recorders are fed to either one of the "phono" inputs to the amplifier.

Turntables

Two turntables are available. One is a *Garrard* 78 r.p.m. intermix, the other a 78 r.p.m. manual. Both units have adjustable speed controls, a very handy gadget with which to cope with varying voltage or frequency problems. Although 45 and 33⅓ r.p.m. equipment could be used, the lightweight pickups which are required will usually be found impractical for use in a moving or vibrating truck. Where lengthy periods of music are called for, the automatic changer and wire recorders have sufficed.

Quite often, only certain passages of a record are to be played. Chalk marks serve as effective starting cues. Stopping the program instantly in a vibrating truck, without resorting to changing volume control settings, is accomplished quite simply by incorporating a pickup shorting switch (push-button type) on the turntable base. Output cuts off instantly at precisely the desired point, allowing the

Fig. 12. Closeup view of top of sound truck with announcer's stand partially collapsed.

pickup to be removed from the record at will.

Actually, a third turntable is available. It is part of the dual voltage 30-watt emergency amplifier and may be operated in place of the 115 volt a.c. units just described, in case of a.c. power failure.

Microphones

Various type microphones are available for both close-talking and omni-directional applications. A high impedance crystal microphone is used for cab announcements, all other hand and floor types being low impedance units. The inputs to the amplifiers are actually high impedance, but *Amperite* LGP low-to-high impedance line transformers precede the first three input channels so that low impedance mikes may be used. Thus, whether the microphones are situated next to or atop the truck, or several hundred feet away, the low impedance lines will assure low loss.

Fig. 10 is a view of the rear of the truck showing reels containing microphone cable. Reels on the right side of the truck hold loudspeaker and power line cables. Also in view is the three-position microphone remote control, which may be operated as far away as 2000 feet. This is especially convenient for shows, pageants, concerts, etc., where volume levels must be changed on cue or with varying conditions. The extension cables on each reel end in male and female *Amphenol* connectors (polarity strictly observed) so that lines may be series connected to form long lines.

Two *Amphenol* feedthrough connectors are installed on the roof-top for external connection to the microphones. One of these may be seen in Fig. 9, at the extreme left. The center outlet shown is the a.c. power output from the power plant and the one on the right is a.c. input used when commercial power is brought in.

Field Telephone

A battery-operated field telephone (see Fig. 2) is a useful adjunct to any sound truck to direct set-up operations. With an observer stationed at the far reaches of the area to be observed, loudspeaker direction and "throw" can be adjusted, as well as amplifier volume and tone control settings. For shows, reviews, concerts, it may also be used for cueing purposes.

Collapsible Platform

Fig. 12 is a view of the roof-top, with the announcer's stand half collapsed. When not in use, the entire stand lies flat upon the roof, and the two ladder side railings and vertical posts are detached and laid into position atop the stand floorboard. The ladder itself is swung up and then pushed forward on rollers under the stand floor. With such clever arrangement, headroom required while traveling is substantially reduced. It may be set up by one person in about two minutes.

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Manufacturers' Literature

Readers are asked to write directly to the manufacturer for the literature. By mentioning RADIO & TELEVISION NEWS, the issue and page, and enclosing the proper amount, when indicated, delay will be prevented.

TV ANTENNAS

One of the most comprehensive TV antenna and accessory catalogues ever issued is currently available from *The JFD Manufacturing Co., Inc.* of 6101 Sixteenth Avenue, Brooklyn 4, New York.

This 12-page booklet lists hundreds of television antenna installation items ranging from all types of antennas to brackets, parts, test leads, alignment tools, and standoffs.

Copies of this booklet may be obtained from the manufacturer, its representatives, or distributors.

FUSE COUNTER CARD

Littelfuse of 4757 N. Ravenswood Avenue, Chicago 40, Illinois, has introduced a "Snap-On TV Fuse Holder" counter card as a sales aid to service technicians, dealers, and distributors.

The card, done in a color scheme of green and white with black lettering, has 24 fuse holders along with a clear and self-explanatory picture which shows how to use the holder for replacing pigtail fuses.

The display is designed to be used either on the counter or hung on the wall. Full details on the new card are available from the company.

DISPLAY FIXTURES

Emerson Radio & Phonograph Corporation of 111 8th Avenue, New York 11, N. Y., has recently brought out a new line of "Silent Salesman" displays to aid dealers in merchandising the company's radios and phono-radios.

The Merchandiser SS-6 consists of a series of shelves to display and demonstrate nine radios and phono-radios while the matching Merchandiser SS-7 is designed with platform and shelves to accommodate three television receivers. Both displays utilize an expanded gold-colored metal grille in diamond pattern over green sprayed masonite for the center panel. Hardwoods, finished in Swedish blonde, are used for the frame of the center panel and the supports. The curved side panels and the shelves are painted a lighter tone of green.

Details on these new display fixtures may be secured from the company's distributors.

RECORDING EQUIPMENT

Rek-O-Kut Company, Inc. of 38-01 Queens Blvd., Long Island City 1, New York, has just issued a new catalogue covering its line of recording and transcription equipment.

Listed and illustrated are portable three-speed phonographs, three-speed record players, dual-speed 16" recording turntables, 16" overhead recording mechanisms, dual-speed 12" recording turntables, transcription turntables, accessories for these units, professional disc recorders, and universal recording amplifiers.

Complete specifications are given on each of the products listed, along with prices and catalogue numbers. Persons actively engaged in work involving the recording and reproduction of sound will find this catalogue a handy reference guide.

AUDIO COMPONENTS

Audak Company, 500 Fifth Avenue, New York 18, New York, has announced the availability of a new catalogue covering its polyphase reproducers, tuned-ribbon units, tone-arms, pickups, cutters, and equalizers.

Performance details, catalogue numbers, and prices are given on the various units in the company's line. Response graphs are provided on the tuned-ribbon and the polyphase units.

A copy of this handy 4-page publication is available on request.

BAKELITE BOOKLET

The *Bakelite Division* of *Union Carbide and Carbon Corporation* has recently published a comprehensive booklet summarizing the characteristics, development, and latest applications of the company's polyethylene resins.

This 24-page booklet gives a brief history of the product and then outlines some of the many uses for polyethylene. Characteristic properties of the substance, a listing of the available forms, and methods of fabricating are also included in the publication.

Copies of this booklet are available from the company at 300 Madison Ave., New York 17, New York.

RADIO SHACK CATALOGUE

Radio Shack Corporation of 167 Washington St., Boston 8, Massachusetts, has just released its 1951 catalogue of electronic parts, complete equipment, and kits.

Available free on written request, the new 172-page catalogue includes listings on test and service instruments, p.a. and high-fidelity music systems, amateur radio equipment, tubes, transformers, connectors, wire and cable, condensers, resistors, batteries, and books.

PHONO NEEDLE CHART

Jensen Industries, Inc. of 329 South Wood Street, Chicago 12, Illinois, has

announced the publication of a new edition of its replacement needle wall chart.

The chart (No. J-24) contains all pertinent information on 89 needles, with actual size silhouette illustrations, and includes every needle on the market today.

Copies of this chart, suitable for hanging on the shop wall, are available without charge from the company's jobbers or from the company direct.

CUSTOM CABINETS

Grand Rapids Woodcraft Corporation of 1400 Front, N.W., Grand Rapids 4, Michigan, has issued a folder covering its "Uni-Mode" custom line of radio, television, recorder, and speaker cabinets.

The booklet describes and illustrates a wide variety of cabinet and base units which can be mixed and matched in an almost infinite number of combinations. All of these units are available in a wide range of woods and finishes. A specification sheet provides complete dimensional and constructional data on the line.

Copies of this publication are available to persons interested in the custom installation of all types of radio and television equipment.

ONAN EXPORT PRODUCTS

D. W. Onan & Sons Inc., Minneapolis 14, Minnesota, has prepared a 12-page, two-color booklet covering its entire line of products which are available to the export market.

Included in the folder is a list of suggestions for negotiating export documents. These suggestions are the result of the company's years of experience in the export market and are designed to assist overseas importers in the preparation of such documents necessary in the import-export trade.

The booklet includes electric generating plants, air-cooled, 4-cycle engines and separate ball bearing generators, water-cooled marine generating plants. A special section of the pamphlet describes the company's electric plant accessories such as rubber-tired two-wheel dollies, automatic controls, line transfer controls, gas-gasoline carburetors, heat exchangers, etc.

Copies of this booklet may be secured from the company at the above address. Ask for Export Folder A-185-C.

PROCUREMENT GUIDE

Trilane Associates, Inc., of 1 Hudson Street, New York 13, New York, is presently offering a copy of its publication "United States Government Procurement" free of charge to manufacturers.

Designed as an aid in obtaining government business, this new 16-page brochure covers all aspects of the procurement picture. The booklet is divided into a number of sections, each dealing with a different aspect of procurement. An introductory section

explains the various methods of procurement and advises bidders on how to obtain information relative to products or services they have to offer. Another section deals with common errors in bidding that often prove harmful to manufacturers in their relations with the government.

PARTS FLYER

Radio Surplus Corp. of 732 S. Sherman St., Chicago 5, Illinois, is currently distributing an 8-page flyer which lists all types of radio components.

Included in the listing are oil-filled condensers, electrolytics, knobs, audio and filter chokes, connectors, sockets, rheostats, relays, terminal strips, transformers, switches, speakers, r.f. chokes, and various mica condensers.

Copies of this publication are available from the company.

CLOCK MOVEMENTS

Of interest to design engineers is the new electric clock movement catalogue recently published by *The Sessions Clock Co.* of Forestville, Conn.

The new catalogue contains complete information, including detailed scale drawings, of the full line of *Sessions* clock movements. The publication is designed to serve as a buying and engineering guide for all users of clock timing movements.

The products listed feature compactness of design and ease of installation. A unique demountable motor feature allows quick assembly and easy disassembly for adjustment without the aid of tools and without disturbing the rest of the mechanism.

Copies of the catalogue are available without charge by writing to Dept. 16 of the company.

MASCO SOUND EQUIPMENT

A new line of economy sound equipment is covered in the recently-published Catalogue No. E-351 released by *Mark Simpson Mfg. Co., Inc.* of 32-28 49th Street, Long Island City 3, New York.

Included in the catalogue are individual amplifiers and complete sound systems ranging from 8 watts to 52 watts for fixed, portable, and mobile installations.

Listed in the catalogue are 8, 18, 27, 36, and 52 watt units, portable carrying cases, and speaker cabinets for various sound installations. A copy of this bulletin, which is of particular interest to sound men and p.a. technicians, is available on request.

SOLDERING GUN DATA

New soldering information which is of particular interest to TV and radio technicians has been included in the new soldering gun catalogue recently issued by *Weller Electric Corp.* of Easton, Pa.

The new catalogue covers the company's complete line of guns for every type of soldering operation. Detailed descriptions are provided on the various models along with list prices and illustrative material.

—30—

Square Wave Testing

(*Continued from page 83*)

tions are changed from stage-to-stage until the distorting stage is found.

Square waves can be produced by any audio generator and some form of wave clipping or limiting circuit.

The simplest type uses two crystal diodes to clip the peaks from the positive and negative portions of sine waves. Fig. 2 shows such a clipper. The resulting waves are not true square waves but are flat topped and will serve nearly as well for audio tests. Suitable switching can be arranged to shut off the clipping action of either diode thus allowing either peak to be clipped and observed.

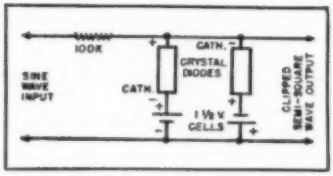
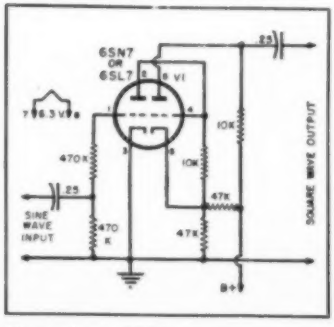


Fig. 2. Simple crystal diode wave clipper.

A vacuum tube squaring circuit is shown in Fig. 3. This circuit will provide excellent square waves for all frequencies between 20 cycles and 10,000 cycles. It should be added to the audio generator inside the cabinet with the switch arranged to connect or remove it from the circuit. The necessary operating voltages can be obtained from the audio generator.

No attempt will be made in this article to cover the interpretation of square waves as this has been covered previously (see "Wide Frequency Range Square-Wave Clipper," by Louis E. Garner, Jr., in the March, 1950, RADIO & TELEVISION NEWS). The square wave will, in addition to indicating frequency response, indicate phase shift, parasitic oscillation, and transient response quickly. Rather than studying published traces and trying to duplicate them, the user is urged to set up the simple tests given in this article and observe for himself the resulting indications. —30—

Fig. 3. A sine wave squaring circuit.



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CABLE REACHES ATLANTA

FINAL cable connections were made to Atlanta, Georgia, the last of September making possible the reception of live programs via the TV network.

A city-wide celebration marked the occasion, with Burr Tillstrom and his Kuklapolitan Players as the star attraction. —30—

TECHNICIANS NEEDED

CIVILIAN electronics and communications engineers interested in assignments in the Pacific area with Airways and Air Communications Service (AACS) have been requested to write the Commanding General, Headquarters AACS, Washington 25, D. C., Attn: Director of Personnel.

AACS urgently needs these engineers to fill positions in grades 7 through 12.

The AACS is part of the Military Transport Service and furnishes air communications and navigational flying aids to U. S. military aircraft throughout the world. —30—

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ERRATUM

In the short item "Crystal Mount" by Rufus P. Turner, appearing on page 74 of the September issue, the measured capacitance of the holder should have been given as 0.9 micromicrofarads instead of 0.9 microfarads. Sorry we slipped up on this.

INDEX OF Advertisers

NOV. 1950

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.

Technical BOOKS

"DATA AND CIRCUITS OF RECEIVER AND AMPLIFIER VALVES," a Symposium. Published by *Philips Industries*, Eindhoven, Holland. Distributed by *Elsevier Publishing Co.*, New York. 409 pages. Price $2.75.

This book is an elaborate and comprehensive "tube manual" covering receiver, amplifier, and rectifier tubes manufactured by *Philips Industries* during the years 1933-1939. Similar publications have made their appearance in the Dutch, French, and German languages but this is the first time that the company has made this book available in English.

The text supplies full technical data and characteristics on the latest *Philips* receiving, amplifying, and rectifying tubes, current regulators and stabilizers and tabular data on other types of receiving and rectifying tubes, as well as electronic tubes (cathode-ray, photoelectric cells, etc.).

The book is roughly divided into two sections, the first covering a.c. tubes, a.c.-d.c. tubes, power output tubes and microphone preamplifier pentodes, rectifying tubes for amplifiers, current regulators and stabilizers, as well as special purpose tubes of various types. The second section contains circuits for a.c. receivers, a.c.-d.c. sets, battery-operated receivers and small phono amplifiers. A special section deals with the various types of *Philips* test equipment for radio and electronic applications.

While the British terminology has been used throughout the text, persons using this book should experience very little difficulty in making the transition to American usage. Designers, service technicians, hams, and students will all find plenty of valuable information in their particular fields included in this publication.

Other books in this *Philips* Technical Library series are currently available or are in the process of preparation.

* * *

"TV INSTALLATION TECHNIQUES" by Samuel L. Marshall. Published by *John F. Rider Publisher, Inc.*, New York. 326 pages. Price $3.60.

The critical shortage of good and practical handbooks covering the proper installation of television receivers and their related antenna systems has been relieved to some extent during the course of this year by the publication of several excellent texts. However, the literature covering this important subject is far from complete and the addition of this new book will undoubtedly be hailed by technicians as a real boon.

Probably the outstanding contribution of this text is the fact that all of the material is *practical*. The author, himself a practicing radio man, hasn't cluttered up his book with a lot of theoretical material. Everything in the book is there because it meets some need of the technician for information on the "why's," "how's," and "wherefore's" of making a good and safe television antenna installation.

Major emphasis has been placed on the mechanics of installation. Even such often-neglected subjects as ice loading, wind surfaces, proper means of guying, etc., come in for their share of attention. The book is divided into nine chapters covering the nature of television, radio propagation, antennas, transmission lines and special antennas, materials and methods used in installations, high masts and tower installations, receiver adjustment and service in the home, and municipal regulations. A fairly comprehensive appendix covers television station listings, specifications on the various types of antenna lead-ins, anchor specifications, a conductor table, a tabulation of the safe loads for standard bolts, a tap and drill chart, picture tube characteristics, basing diagrams, a decibel conversion chart, a transmission line attenuation graph, a twin-lead nomograph, and instructions on the correct way to administer artificial respiration (a "must" working tool for all persons working in television).

Television technicians would do well to add this book to their tool kits as it provides all of the answers to those tricky installation problems so often encountered.

—30—

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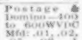

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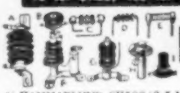

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2B7	1.33
2B22/GL559	.73
2C21/1642	.81
2C22/7193	.89
2C26	.15
2C34/RK34	.21
2D21	1.80
2E5	1.16
2V3G	.49
2W3GT	.98
2X2	.49
2X2A	1.92
3A4	.32
3A5	1.25
3A8GT	2.40
3B4	3.49
3B5	.98
3B7/1291	.29
3D6/1299	.29
3D21A	1.98
3E29	10.98
3LF4	1.33
3Q4	1.98
3Q5GT	2.16
3S4	1.80
3V4	1.80
5R4GY	1.50
5T4	1.72
5U4G	1.50
5V4G	2.40
5W4	.83
5X4G	.90
5Y3GT	1.25
5Y4	.75
5Z3	.62
5Z4	1.33
C6A	7.40
6A3	2.40
6A4	1.60
6A6	1.33
6A7	1.00
6A8GT	1.00
6AB4	2.00
6AB5/6N5	1.33
6AB7/1853	1.42
6AC5	1.45
6AC7	2.90
6AC7W	3.60
6AD5	1.19
6AD6G	1.20
6AD7	1.60
6AE5	.89
6AF5	.89
6AF6G	1.33
6AG5	2.65
6AG7	2.88
6AH6	3.90
6AJ5	2.29
6AK5	3.90
6AK6	2.40
6AL5	2.00
6AL5W	2.90
6AL7	1.33
6AN5	6.00
6AQ5	2.00
6AQ6	.90
6AQ7GT	2.40
6AR5	1.65
6AR6	4.58
6AS5	2.00
6AS6	1.89
6AS7G	6.75
6AT6	1.50
6AU5GT	2.65
6AU6	2.00
6AU7	2.40
6AV5GT	1.33
6AV6	1.50
6AW6	2.85

Type	Price
6AX5GT	$1.35
6B4G	1.60
6B5	1.60
6B6	1.10
6B7	1.60
6B8G	1.42
6BA4	1.08
6BA6	1.80
6BA7	1.20
6BC5	2.00
6BD6	1.06
6BE6	1.80
6BF6	1.49
6BG6G	4.80
6BH6	2.00
6BJ6	2.00
6BQ6GT	3.20
6C4	1.65
6C5	.83
6C6	.89
6C7	1.26
6C8G	1.42
6CB6	2.00
6CD6G	6.00
6D6	.83
6D8	1.60
6E5	1.10
6E6	1.90
6E7	1.20
6F5	.83
6F6	1.65
6F6GT	1.65
6F7	1.60
6F8	1.60
6G6	1.33
6H6	1.49
C6J	4.98
6J4	6.98
6J5GT	1.50
6J6	2.90
6J7	1.80
6J8GT	1.60
6K5GT	2.16
6K6GT	1.65
6K7	.73
6K8	1.07
6L5	1.33
6L6	3.20
6L6GA	2.61
6L7	1.07
6N4	1.08
6N6G	1.95
6N7GT	1.28
6P5GT	2.40
6Q7	1.00
6R7	1.33
6R8	1.49
6S4	1.65
6S7	1.60
6S8GT	2.65
6SA7GT	1.65
6SB7Y	1.20
6SC7	1.00
6SD7GT	1.45
6SF5	.83
6SF7	1.00
6SG7	2.00
6SH7GT	2.00
6SJ7	1.65
6SK7GT	1.65
6SL7GT	2.40
6SN7GT	2.20
6SN7WGT	2.90
6SQ7GT	1.50
6SR7	1.80
6SS7	.90
6ST7	1.33
6SU7GTY	3.37
6SV7	1.45
6T7G	1.60
6T8	2.90
6U4GT	2.40
6U5/6G5	1.00
6U6GT	1.06
6U7G	.90
6V6	3.20
6V6GT	2.00
6V6GTY	2.45
6V7G	1.18
6W4GT	1.80
6W4WGT	2.50
6W5GT	.75
6W7G	1.33
6X4	1.50
6X5GT	1.50
6Y5	1.85
6Y6G	2.40
6Y7G	.98
6Z5/12Z5	1.18
6Z7G	1.95
6ZY5G	1.10
7A4/XXL	1.00
7A5	1.10
7A6	.90
7A7	1.62
7A8	.90
7AD7	2.39
7AF7	.90
7AG7	.98
7AH7	1.10
7B4	1.62
7B5	1.62
7B6	1.62
7B7	.90
7B8	.90
7C4/1203A	.33
7C5	.79
7C6	1.62
7C7	1.62
7C23	69.00
7E5/1201	1.33
7E6	1.10
7E7	1.33
7F7	1.10
7F8	2.39
7G7/1232	1.33
7H7	1.80
7J7	1.33
7K7	1.33
7L7	1.33
7N7	.98
7Q7	.90
7R7	1.10
7S7	1.33
7T7	1.03
7V7	1.33
7W7	2.39
7X7/XXFM	1.33
7Y4	.90
7Z4	1.62
10Y	.29
12A6	2.16
12A7	1.60
12A8GT	1.00
12AH7GT	1.33
12AL5	1.00
12AT6	1.50
12AT7	2.90
12AU6	2.00
12AU7	2.40
12AV6	1.50
12AV7	2.90

Type	Price
12AW6	$2.65
12AX7	2.40
12BA6	1.80
12BA7	2.40
12BD6	2.00
12BE6	1.80
12BF6	1.65
12BH7	2.40
12C8	1.42
12E5	.98
12F5	.90
12H6	1.80
12J5GT	.75
12J7GT	1.00
12K7GT	.83
12K8	1.07
12L8GT	1.59
12Q7GT	.90
12S8GT	.90
12SA7GT	1.65
12SC7	1.10
12SF5GT	1.00
12SF7GT	.89
12SG7	1.00
12SH7	.98
12SJ7GT	1.65
12SK7M	1.65
12SL7GT	1.07
12SN7GT	2.20
12SQ7GT	1.50
12SR7	.98
12X3	.90
12Z3	1.33
14A4	1.33
14A7/12B7	1.98
14AF7/XXD	1.26
14B6	1.98
14B8	1.10
14C5	1.33
14C7	1.20
14E6	1.10
14E7	1.33
14F7	1.10
14F8	1.33
14H7	1.20
14J7	1.33
14N7	1.33
14Q7	1.98
14R7	1.33
14S7	1.33
14W7	1.33
14X7	1.33
14Y4	1.20
15E	1.17
15R	.49
FG17	3.98
RK18	.98
19	1.60
19BG6G	6.00
19J6	3.20
19T8	2.90
20	1.17
RK20A	6.98
PJ21	4.98
REL21	4.85
RX21	2.33
PJ22/CE1C	1.49
HY24	1.39
24A	1.10
24G/3C24	.69
25A6	1.60
25A7	3.27
25AC5GT	1.95
25B5	1.39
25B6	2.49
25BQ6GT	3.20
25C6	1.18
25L6GT	1.65
25N6	1.69
25W4GT	2.00
25Y5	1.45
25Z5	.75
25Z6GT	1.35
26	.90
27	.75
FG27A	6.89
28D7	.28
30	1.00
HY31Z	4.89
31	.57
32	1.78
FG32	4.89
32L7GT	1.60
33	1.60
FG33	7.89
34	1.60
35/51	1.00
35A5	.90
35B5	2.00
35C5	2.00
35L6GT	1.49
35W4	2.00
35Y4	1.62
35Z3	.90
35Z4GT	.75
35Z5GT	1.50
REL36/6J4	.54
36	1.33
37	.90
38	1.10
39/44	1.33
CRC40	.54
41	.83
42	.83
43	.83
45S/VT52	.18
45Z3	.90
45Z5	.90
46	1.33
47	1.20
49	1.33
50	1.95
EF50	.69
50A5	1.98
50B5	1.80
50C5	1.80
50C6	1.28
50L6GT	1.65
50X6	1.10
50Y6	.90
50Y7GT	1.00
53	1.33
56	.90
57	1.00
58	1.00
59	1.78
RK61	1.98
RK65	24.95
HY69	4.95
70A7	1.49
70L7GT	1.95
71	1.00
72	.95
CRP72	1.37
73	1.67
NR74	.29
75	.83
HY75A	4.59
76	.83
77	.83
78	.83
79	1.33
80	1.35

Type	Price
81	$1.95
FG81A	4.45
82	1.33
82V	1.39
83	1.33
83V	1.60
84/6Z4	.90
85	1.10
89	.32
VR92	.25
FG104	14.98
FG105	8.89
VU111	.49
HY114B	1.25
HY115/145	.57
117L7	1.95
117N7GT	1.95
117P7GT	1.95
117Z3	1.35
117Z4GT	1.45
117Z6GT	1.20
117Z7GT	1.49
F127A	15.89
CV148	4.98
155	.98
FG166	49.00
FG172	29.50
FG190	12.80
205B/VT2	1.69
CE206	3.15
211/VT4C	.37
RX215	9.95
WE215A	.25
227A	2.65
231	1.20
250TH	18.75
250TL	18.75
282B	8.49
304TH	3.45
304TL	3.98
307A/RK75	6.45
310A	6.98
316A	.29
323A	8.98
327A	2.50
350	1.49
350B	1.65
355A	14.15
371B	.98
380A	.79
388A	1.69
393A	3.45
394A	4.98
395A	4.95
FP400	7.98
WL414	63.95
417A	9.49
GL434	2.69
446A/2C40	1.19
446B	1.75
450TH	19.75
450TL	44.25
GL451	1.90
460/HF200	13.95
WL468	5.89
RH507	9.98
527	8.98
530	12.69
WL531	3.75
GL534/1521	3.89
544	4.98
GL546	1.69
550P1	19.95
575A/975	12.65
601B	.19
HY615	.18
WL619	18.90
KU627	6.85
WL632A	8.98
701A	2.90
702A/702B	2.65
703A	3.98
704A	2.98
705A/8021	.65
707	9.98
710A/8011	.69
713A	1.00
715A/B	7.98
715C	24.98
717A	.61
721A	2.19
722A/287A	9.95
723A	6.95
724A/B	2.89
725A	6.39
726A	5.98
726C	29.98
730A	9.89
801A	.29
802	4.69
803	2.89
804	6.90
805	3.59
807	2.39
808	.95
809	2.45
810	11.96
811	2.29
812	2.50
813	11.75
814	2.39
815	1.37
816	1.18
826	.39
SD828	1.98
829	6.48
829B	14.98
832	7.98
832A	10.64
836	1.98
837	1.29
838	2.21
842	2.75
843	.39
845	5.95
851	29.98
860	5.70
861	9.89
864	.29
865	1.39
866A	.98
866Jr	1.04
868/PJ23	1.90
869	25.98
872A	1.29
GE872A	2.98
874	.35
876	.29
878	1.95
884/6Q5G	1.45
885	.96
920	2.70
922	1.19
923	.77
927/CE25	1.20
929	1.33
930	.90
931A	4.98
954	.24
955	.49
956	.39
957	.39
958	.39

Type	Price
SD968	$1.98
991	.36
FM1000	1.20
CK1005	.49
CK1006	.64
CK1007	.89
CK1089	3.98
CK1090	2.69
R1100	5.00
R1130B	12.00
HY1231Z	5.39
HY1269	5.39
1273	1.15
1280	1.15
1609	5.98
1613/6F6K	1.06
1614	1.35
1616	.75
1619	.39
1620	4.95
1622	1.75
1624	1.05
1625	.49
1626	.49
1629	.39
1632	.77
1633	.75
1634	.77
1635	1.49
1641/RK60	.98
2050	1.80
2051	.49
R4340	38.00
5514	4.85
5516	5.85
5517/CK1013	1.89
5656	18.90
5686	4.23
5812	2.99
UX6653	.69
8012A	1.25
8013A	7.98
8020	1.25
9001	2.79
9002	2.25
9003	2.79
9004	.24
9005/RC48	1.95
9006	.16

C'RAY TUBES

Type	Price
2AP1	3.55
2AP5	7.98
3AP1	4.69
3BP1	2.39
3BP1A	7.98
3CP1S1	2.49
3DP1	3.75
3DP1-S2	4.65
3EP1	2.45
3FP7	1.69
3GP1	4.89
3HP7	4.80
3HP14	9.98
3JP1	19.50
3JP12	19.95
4AP10	4.70
5AP1	3.75
5BP1	2.25
5BP4	4.50
5CP1	1.75
5CP7	3.70
5FP7	1.26
5FP14	18.98
5GP1	6.95
5HP1	4.95
5HP4	6.75
5JP1	39.95
5JP2	11.75
5LP1	11.89
5MP1	4.75
5NP1	3.98
7BP7	4.65
7CP1	12.95
7JP4	16.49
9GP7	8.89
9LP7	10.98
10BP4	19.49
10FP4	24.50
12DP7	12.45
12GP1	49.98
12GP7	12.70
12JP4	27.00
12KP4	34.00
12LP4	24.35
12QP4	32.00
12RP4	36.00
15DP4	56.00
16AP4	49.00
16DP4	49.98
16FP4	57.50
16RP4	49.98
16TP4	49.98
19AP4	96.00
19CP4	85.00
905	2.45
910/3AP1	4.63
912	89.98
914A	45.00

BALLAST

Type	Price
1P1	.49
PM3	.98
PM4	.98
4A1	1.29
PM5	.98
6-11	.49
PM6	.98
PM7	.98
PM8	.98
9-3	.49
10-48	.49
13-4	.49
20-4	.49
K49A	.36
K55B	.36
M55B	.36
L62A	.49
K80B	.36

MAZDA PILOTS

Type	Price
44.Box10	.50
49.Box10	.60
55.Box10	.50
64.Ea.	.07
56 T4 3W	.18
100W 20V	.25
291.Box10	.36
311 28V	.15
313 28V	.15
323 3V	.10

NEON BULBS

Type	Price
NE16/991	.38
NE32	.35
NE45 ¼W	.27
NE51/NE20	.07

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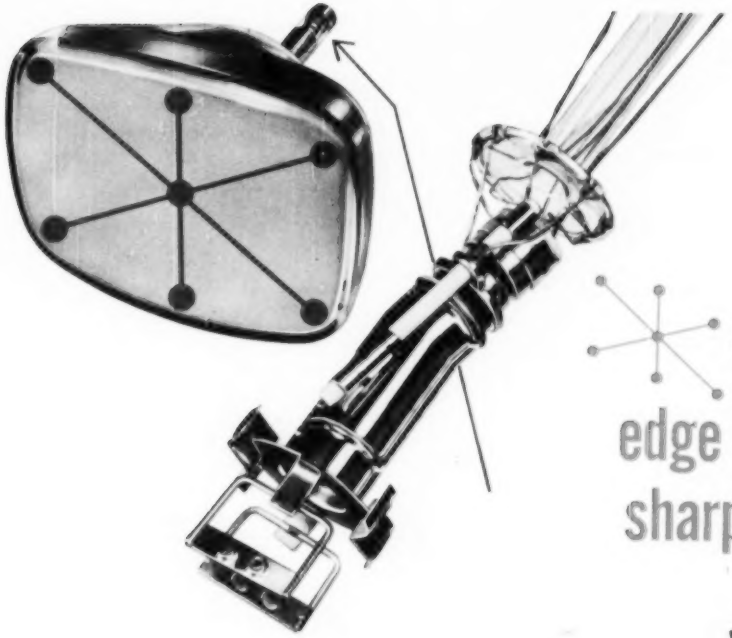

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Uniform sharpness of trace to the very edges of the screen distinguishes the new Du Mont Bent-Gun.

A higher degree of pre-focusing passes a smaller-diameter beam through the deflection field. Spot distortion is reduced and a uniform overall focus results. Other design changes are: Improved bulb spacer insures proper anode contact and electron gun centering; rounded corners on pertinent gun parts eliminates stray emission at higher anode voltages; new grid-cathode assembly allows a longer G-2 (second grid) without increasing overall length.

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Teletrons*

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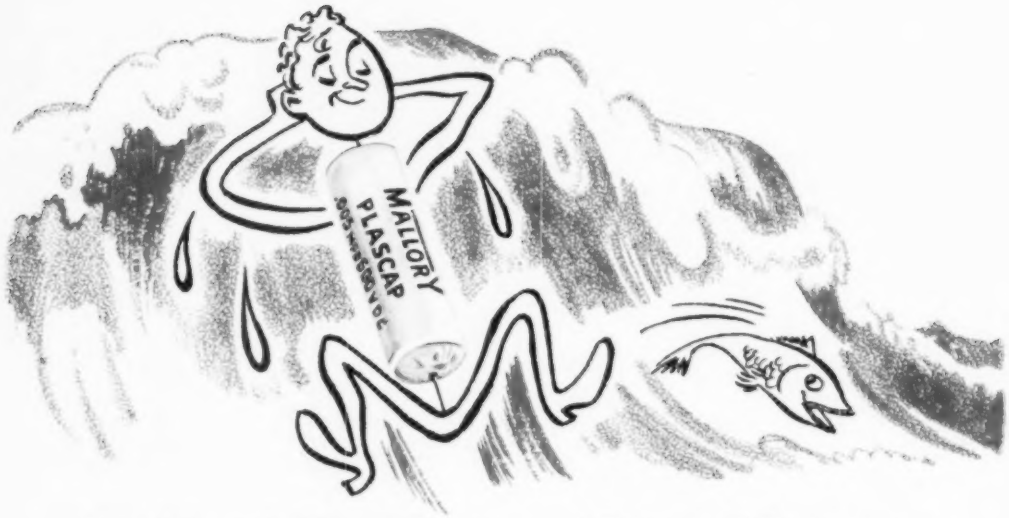

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When you select Mallory FP Capacitors, you can be sure of their performance even in circuits where heat is a problem. Every Mallory FP Capacitor will operate continuously at 85° C. In addition, Mallory FP Capacitors are famous for their long shelf-life . . . you can depend on them when you need them. Buy the one line that services both AM and TV sets. They are an outstanding example of Mallory Precision Quality at standard prices.

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